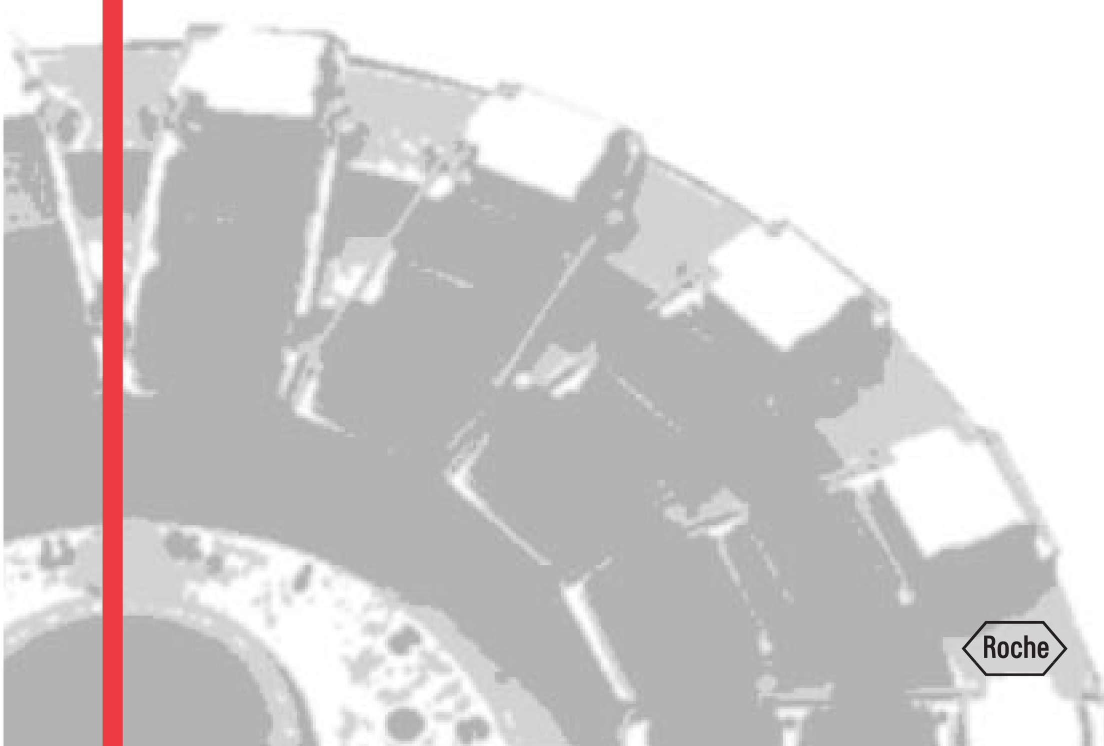
Reference Guide

Roche Diagnostics Elecsys® 2010 System Operator's Manual



Roche

Reference Guide
Table of Contents

Chapter 1 – Introduction

Reference Guide – Table of Contents

Chapter 2 – System Description

Reference Guide – Table of Contents

Chapter 3 – Mechanical Theory

Chapter 4 – ECL Technology

Chapter 5 – Test Principles

Chapter 6 – Calibration

Notes

Chapter 1

Introduction

1.1 Introduction

Introduction

The Reference Guide is part of the total documentation for the Roche Diagnostics Elecsys® 2010 Immunoassay System, additionally consisting of the Software Guide, User's Guide, Tutorial Guide and the Short Guide.

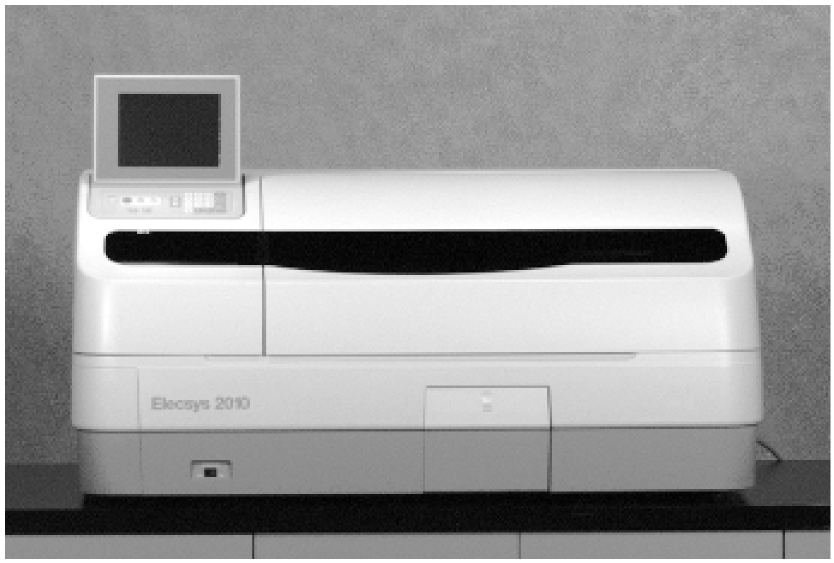
The Reference Guide gives a comprehensive overview of the Elecsys 2010 Immunoassay Analyzer. Furthermore, this guide gives background information on all system-specific topics that are not necessarily part of the daily routine, but give valuable information on the function of the entire system.

The Reference Guide covers all topics relating to the functionality of the instrument and the technical data. In addition, it contains descriptions of the measuring methods on which the tests are based.

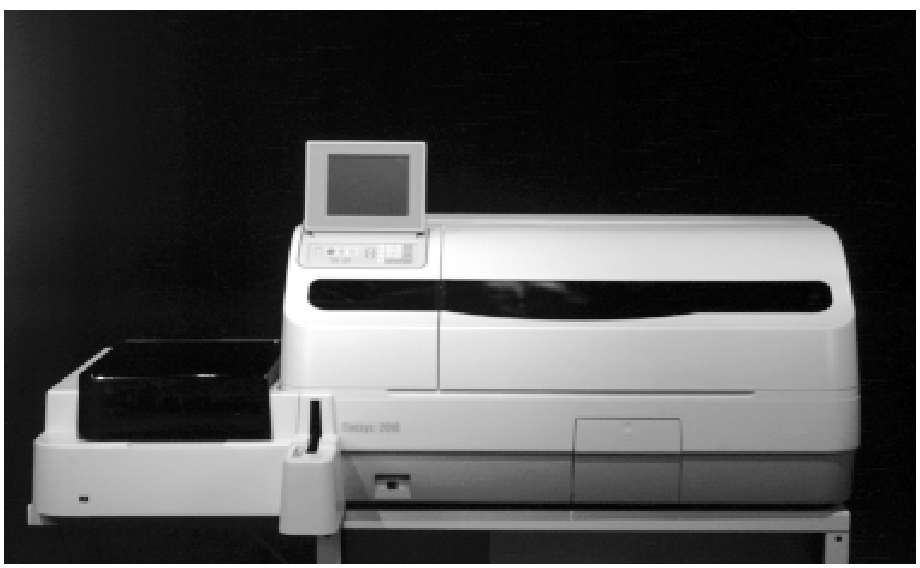
The Reference Guide also describes in detail the safety precautions that must be heeded while working with the 2010 system.

The Elecsys 2010 Immunoassay System

The Roche Diagnostics Elecsys 2010 Immunoassay System is a fully automated, random access, software-controlled system for immunoassay analysis. It is available as both a disk system and a rack system. The differences between the two configurations are detailed throughout this operator's manual.



Elecsys 2010 disk system



Elecsys 2010 rack system

1.1 Introduction

The Elecsys 2010 was designed for both quantitative and qualitative in vitro determinations using a wide variety of tests. Both disk and rack systems have a throughput per hour of approximately 86 tests.

The Elecsys 2010 analyzer can be placed on a bench top, thus saving space in the laboratory environment. Handling of the system is easy; potential for manual errors is reduced to a minimum. All assay reagent, calibrator and control information is automatically entered into the software by bar codes.

The system consists of the analyzer, which performs all functions required for fully automated sample and assay processing, and a control unit, which controls the analyzer through the user software. This entirely automated process begins with the recording of patient samples - provided that they are in bar code-labeled tubes - up to the electrochemiluminescent detection and results transmission.

Data transmission to and from the analyzer, results evaluation, documentation, and quality control are performed automatically by the software. Furthermore, the software is responsible for the management of data between a connected laboratory information system (LIS) and the 2010. Several Elecsys analyzers can be centrally controlled when integrated with the Laboratory System Manager (LSM) designed by Roche Diagnostics.

An outstanding feature of the analyzer system is the touchscreen and easy to use software. The advantages of the system include:

- Easy operation via touchscreen, very few manual entries required.
- Integrated bar code concept improves convenience and workflow. Manual entry of individual sample identifications is not required, if bar code-labeled tubes are used. Sample racks (on the rack system), reagent packs, calibrator and control vials (also bar code-labeled) are also read automatically.
- Automatic entry of test applications. Transfer of test parameters to the system via the reagent bar code label speeds installation of new assays.
- Real time monitoring of the analyzer allows the system to run unattended. The operator is immediately notified of any problems.
- Continuous access to samples avoids interruptions of the routine testing while ensuring that results will be available as quickly as possible.
- STAT samples are prioritized and processed first.
- Reagents are kept at a constant temperature (20 ± 3 °C) on the analyzer, allowing on analyzer storage.

1.2 General Overview

Introduction

The Roche Diagnostics Elecsys 2010 Immunoassay System is an automated, random access, multichannel analyzer for immunological tests, intended for in vitro quantitative or qualitative determination of a wide range of analytes. The analyzer is specially designed for performing assays utilizing electrochemiluminescent (ECL) technology and is marketed by Roche Diagnostics.

Packaged with your analyzer, you will receive an:

- accessory kit
- installation kit.

After your instrument is installed, the following consumable materials should be ordered as necessary from Roche Diagnostics:

- reagents
- calibrator sets
- CalCheck kits (USA only)
- Elecsys ProCell
- Elecsys CleanCell
- Elecsys BlankCell
- control material
- assay cups
- assay tips
- CalSet Vials (empty calibrator/ control vials)
- Clean-Liners
- printer paper
- printer ribbon.

General

This operator’s manual is intended to be used as an instructional aid in the performance of tasks related to the operation and general maintenance of the instrument. The manual contains detailed descriptions of instrument features and general operational concepts, specifications, theory of operation, function and use of controls, operating techniques, emergency procedures, product labeling and maintenance procedures.

Warranty

For warranty conditions, refer to the analyzer purchase agreement. Contact your local Roche Diagnostics representative for further information.

1.2 General Overview

Using the Operator's Manual

The arrangement of this manual is planned for a sequential, progressive, programmed style of study. Anyone attempting to operate the instrument should not do so until thoroughly familiar with the information in this manual. The key to good performance is good preparation by thoroughly studying the information contained in this manual.

The manual is divided into the following four guides:

- **Reference Guide:** This book provides general information about Roche Diagnostics (e.g., ordering reagents and contacting technical support), an introduction to the analyzer, instrument specifications, precautions and warnings, mechanical and chemistry methodology theory.
- **Software Guide:** This book describes in detail the software on the analyzer. A basic organization and navigation, as well as detailed menu/screen displays are provided. Reports available from the analyzer are also found in this book.
- **User's Guide:** This book contains general troubleshooting, data and instrument alarms, maintenance and a spare parts list.
- **Tutorial Guide:** This book provides a basic overview of the system, daily operational procedures and a "How to..." section (i.e., instructions on most tasks the average operator is required to perform).

Also included with the manual is the **Short Guide**. This small document is designed to complement your operator's manual. The Short Guide tells you exactly what is necessary to operate the analyzer, without the level of detail found in the Tutorial Guide. Please refer to the Tutorial Guide of your operator's manual for additional operational details.

Manual Set-up

The general table of contents at the beginning of each guide and the subject index located in the back of the guide, provide points of quick correlation for cross referencing. Pictorials are repeated as necessary to minimize page flipping and references are made between sections to point out specific guide information.

Manual Revisions

The arrangement of the manual facilitates easy updating and revision. Page revision packages are issued from time to time for user insertion into the manual. Instructions accompany each revision package.

Analyzer Installation

Installation is performed by a Roche Diagnostics representative. The customer is responsible for providing the necessary facilities as detailed in Section 2.7, Technical Data.

Service

Contact your local Roche Diagnostics representative for further information regarding the Elecsys 2010 analyzer service agreement.

Customer Training

Contact your local Roche Diagnostics representative for questions regarding Elecsys 2010 analyzer training.

Test Specific Information

Information specific to a particular chemistry test can be found in the chemistry package insert and/or product information for that method. Assay product informations are located in your product information binder.

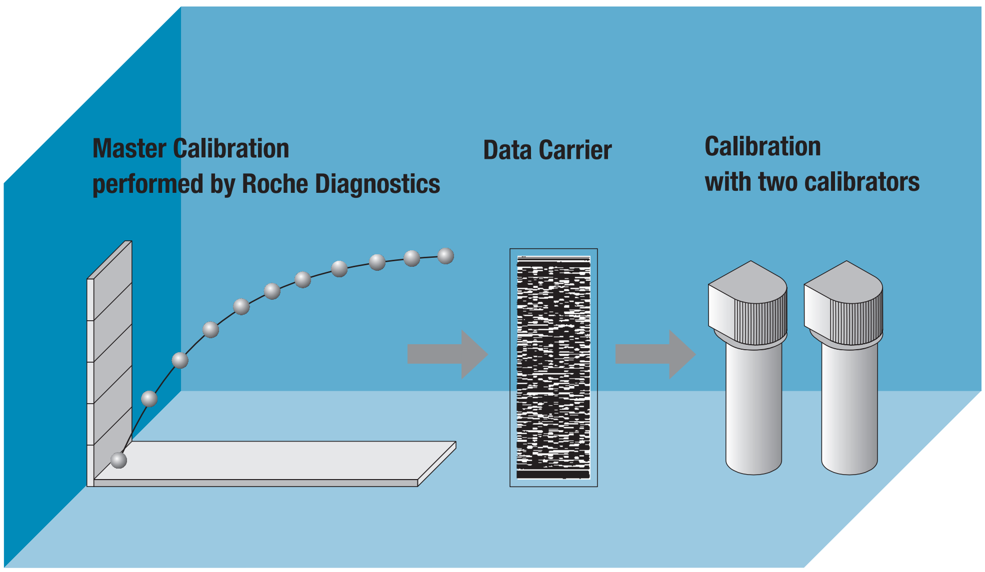
Ordering Information

Replacement parts, consumable materials, reagents, calibrators and controls should be ordered as necessary from Roche Diagnostics. When ordering, please use the Roche Diagnostics catalog number and reference name for each item.

1.3 Product Labeling

Introduction

Elecsys reagent packs have a special 2D (two dimensional) bar code. This allows fully automatic registration and management of reagent information. Manual entry or additional monitoring is not necessary. The ready-to-use, liquid reagents are loaded into one of the 18 positions on the reagent disk. Reagents are available for analysis after their bar codes are scanned.



Calibrators

The handling of calibrators and Roche Diagnostics controls corresponds to that of reagents. Most calibrators are ready-to-use. Lyophilized controls and some calibrators must be prepared and transferred into the appropriate container. For quantitative assays, calibrator and control information is stored on 2D bar code cards (refer to subsection, Calibrator and Control Bar Code Cards). For qualitative assays, all information necessary for calibration is encoded on the bar-coded bottle labels contained in the kit.

Reagent Kits (Reagents Packs)

The photo shows an example of the reagent pack used on the Elecsys 2010 analyzer. Each reagent pack is a ready-to-use single unit.
A reagent pack consists of three bottles:

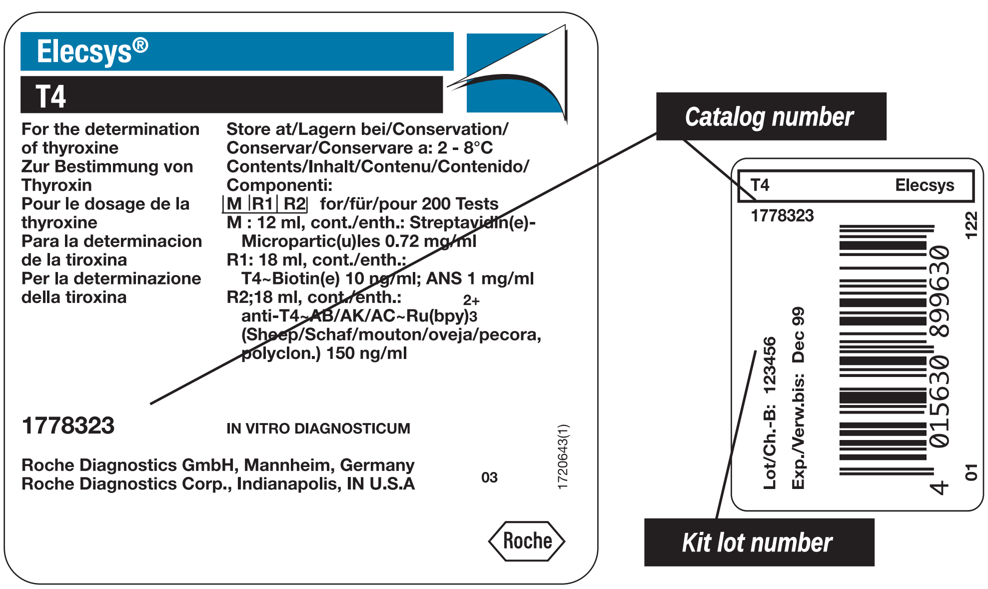
- a white bottle with a white or transparent lid containing the suspended paramagnetic microparticles, that act as the carrier material of the ruthenium-labeled complex during measurement
- a black bottle with a gray lid containing R1
- a black bottle with a black lid containing R2.

Elecsys reagent pack

The reagent pack and reagent disk are keyed so reagents cannot be placed incorrectly on the analyzer.

Reagent Kit Box Labels

The following are examples of typical box labels for an Elecsys reagent kit. The large label contains the intended use statement, storage temperature, contents and catalog number of the kit. The smaller side box label contains the lot and expiration date of the kit, as well as a bar code number. This bar code number is used for tracking purposes and is not used by the analyzer.



Elecsys reagent box labels (actual size)

1.3 Product Labeling

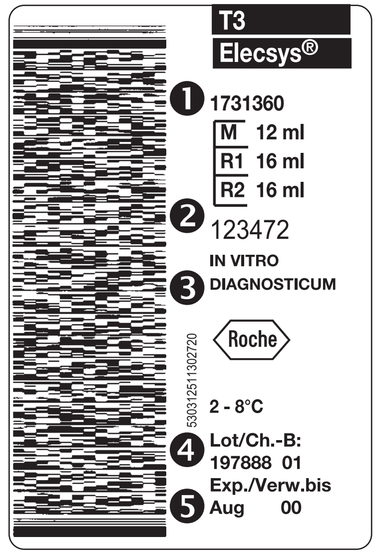
Reagent Bar Code Label

Reagent packs have a bar code label that contains information required to run the assay on the analyzer. This information includes, but is not limited to:

- test number
- lot number
- master calibration curve parameters (e.g., Rodbard parameters)
- instrument settings
- calibrator lot numbers and assigned values
- expiration date
- calibration frequency.

The following information can be identified on each reagent bar code label:

❶ kit catalog number
❷ reagent pack number
❸ reagent bar code number
❹ kit lot number
❺ expiration date.



T3 reagent bar code label (actual size)

Additional information on the reagent pack number and reagent bar code number can be found in Section 2.2, ‘Reagent Details’ Pop-up Window – *Software Guide.*

The reagent bar code labels are in a unique format. The symbology utilizes portable data files (PDF) and is called PDF417. Traditional linear bar codes serve as a link to a database that contains the appropriate information. PDF417 is a two-dimensional, stacked bar code that contains an entire data record. The large amount of data that can be encoded allows all instrument settings to be included, as well as the master calibration curve and additional information for the assay. It is from this master calibration curve and from the operator 2-point calibration that the analyzer derives the update of the master calibration curve. For further information, refer to Chapter 6, Calibration.

“Every PDF417 symbol (bar code) contains two error detection codewords that are used like the check digit in linear bar code symbologies to detect decode errors and verify that all data have been read and decoded accurately. Additionally, PDF417 provides error correction in the event that portions of the symbol have been damaged, destroyed or are unreadable.”[1]

1. Itkin S, Martell J. *A PDF417 Primer: A Guide to Understanding Second Generation Bar Codes and Portable Data Files*. Bohemia, NY: Symbol Technologies, Inc; 1992:17-18.

It is a combination of this error detection and error correction that ensures a reliable bar code. There should only be exceptional cases when bar codes are so badly damaged that they cannot be read by the analyzer. If the bar code cannot be read and the reagent lot has been previously used by the analyzer, the 15-digit number found on the reagent bar code label can be manually entered into the software.

Calibrator and Control Kits

Calibrators and controls for the Elecsys reagents come packaged separately (e.g., Elecsys Troponin-T CalSet or Elecsys PreciControl Universal). Each kit contains either bar-coded calibrator or bar-coded control vials ready-for-use on the analyzer. Most calibrators are in a ready to use liquid form and require no further action other than to place them on the sample disk or rack when a calibration is necessary.

PreciControl Universal kit

A few of the calibrators and the controls are lyophilized in glass bottles and must be reconstituted before being transferred into plastic bar code-labeled vials. (Empty bar code-labeled vials are packaged in these kits with lyophilized calibrators or controls.) Reconstituted calibrators and controls can be stored in the plastic vials after transfer.

Calibrators and controls also have color-coded caps to assist you in identification. A white cap is a level one calibrator/control and a black cap is a level two calibrator/control.

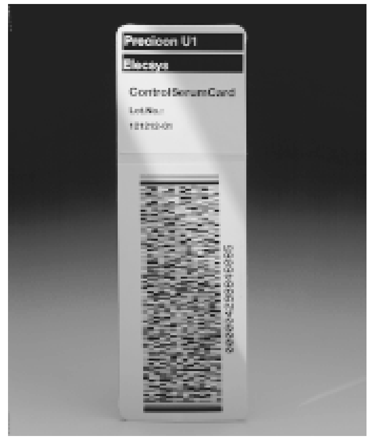
A calibrator or control bar code card comes packed in each calibrator or control kit, respectively. These cards are described in more detail on the next pages.

1.3 Product Labeling

Calibrator and Control Bar Code Cards

Each calibrator and control kit comes with a bar code card. These cards are also in the PDF417 format and must be used in conjunction with the corresponding controls and calibrators. Information encoded in the calibrator/control bar code cards includes, but is not limited to:

- test number
- calibrator/control lot number
- control code (e.g., PC U1) (control card only)
- lot identifier to calibrator/control bar code labels
- what calibrators are to be used and their number of determinations (calibrator card only)
- target or assigned values
- control ranges (control card only)
- expiration date.



PreciControl bar code card

Roche Diagnostics produces a factory master calibration for each calibration lot. The results are encoded into the corresponding reagent bar code. Scan the new bar code card when a new lot of calibrator or control is used.

Calibrator and Control Bar Code Labels

Each calibrator and control bottle has a traditional linear bar code label that contains an identifier to link it to information encoded in the reagent bar code label and the calibrator or control bar code card.

Calibrator bottle bar code labels

Package Insert

Each reagent kit comes with a package insert. This insert contains information required to perform the assay. Detailed information is contained in the product information sheet supplied separately.

Product Information Sheet

Each assay applied to this analyzer will have a product information sheet that provides general information about the assay. Data contained in the product information sheet is more detailed than what is in the package insert. Instrument settings are encoded in reagent bar codes and not entered by the operator. This type of information, such as sample volume, reagent volume, etc. is found in the *Overview* section of the product information sheet.

1.4 Potential Hazards and Safety Precautions

Introduction

Before you start working with the analyzer, acquaint yourself with all safety precautions and regulations concerning handling of materials and the system's electrical and mechanical components.

Chemical

The operator is responsible for taking all necessary precautions against hazards associated with the use of clinical laboratory chemicals. Specific recommendations for each reagent used on the analyzer are found on the box label, package insert or product information sheet for each chemistry. Material Safety Data Sheets (MSDS) are available for Roche Diagnostics reagents.

Immediately remove any reagent spillage from the instrument.

Electrical

DO NOT attempt to open the instrument covers and work in any electronic compartment. An electrical shock may occur.

Mechanical

As with any mechanical system, there are certain precautions to take when operating the instrument. *DO NOT* wear loose garments or jewelry that could catch in moving mechanisms. *DO NOT* put your hands into the pathway of any moving parts while the analyzer is operating. Particular areas to avoid are the A-Line (rack system), B-Line (rack system), C-Line (rack system), sample/reagent probe, gripper (tip/cup carrier) and the sipper probe. Operate the instrument with the covers down unless you place additional samples on the sample disk or A-Line, or remove samples from the sample disk or C-Line. *DO NOT* attempt mechanical repair unless the instrument is in Stand-by or OFF.

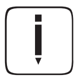
Biohazardous Materials

As with all in vitro diagnostic equipment, patient samples and serum-based quality control (QC) products that are assayed on this system, as well as all waste from the waste containers, should be treated as potentially biohazardous. All materials and mechanical components associated with the sampling and waste systems should be handled according to your facility's biohazard procedure. Use the personal protective equipment recommended by your facility when handling any of these components.

1.4 Potential Hazards and Safety Precautions

Visual Cues

Throughout this manual, three icons are used to draw attention to certain information. These are listed below.



Notes contain information about a topic in the text.

Caution messages contain information which, if not observed, could result in loss of data or in damage to the analyzer.

Warning messages contain information which, if not followed, could cause serious personal injury and/or damage to the analyzer.

Warning Stickers

There are three different stickers that appear on the 2010 analyzer. These stickers are also used to draw your attention to certain conditions. The stickers are listed below.

This sticker warns you that there are mechanisms in action within the vicinity of this sticker. In addition, these mechanisms are in contact with potential biohazards. Keep your hands out of this area while the analyzer is in operation.

This sticker warns you that there are potential biohazards within the vicinity of this sticker. Take the necessary precautions and handle all material in this area as potentially infectious.

This sticker warns you that there are corrosive or caustic reagents within the vicinity of this sticker. Take the necessary precautions and handle the reagents with care.

1.4 Potential Hazards and Safety Precautions

Potential Hazards and Safety Precautions

Mechanisms in Action

1. Verify that all analyzer lids are closed during operation.
2. Avoid touching the A-, B-, or C-Lines, sample/reagent probe mechanism, sipper probe mechanism, gripper (tip/cup carrier) mechanism, mixing mechanism and other moving parts while the instrument is operating. Otherwise, personal injury may result.
3. Verify sampling has stopped when you load additional samples on the sample disk or remove processed samples from the sample disk while the analyzer is in operation. Or, verify there is no rack movement (i.e., rack indication light is green) when you load additional sample racks on the A-Line or remove processed sample racks from the C-Line while the analyzer is in operation. Otherwise, personal injury may result.

Samples

1. Treat all samples as potential biohazards. If sample spills on the instrument, utilize correct personal protective equipment (PPE-gloves, lab coat, etc.) and wipe it off immediately.
2. Make sure that the sample does not contain any fibrin, dust or other insoluble contaminants. If insoluble contaminants are contained in the sample, correct measuring values may not be obtained.

Waste Solution and Solid Wastes

1. Avoid direct contact with waste solution and/or solid wastes. Both should be handled as potential biohazards.
2. Dispose of waste solution and/or solid wastes according to the relevant governmental regulations.
3. Consult the reagent manufacturer for information on the concentrations of heavy metals and other toxic constituents in each reagent.
4. ***Do not add bleach*** to the liquid waste container. Bleach combined with the contents of the liquid waste could cause potentially harmful fumes.

1.4 Potential Hazards and Safety Precautions

Biohazardous parts

1. Avoid direct contact with the sample/reagent probe, sipper probe and rinse stations. Treat as potentially biohazardous areas.
2. Verify sampling has stopped before you load additional samples on the sample disk or remove processed samples from the sample disk while the analyzer is in operation. Otherwise, you may touch the potentially biohazardous sample/reagent probe.

Reagents

1. Avoid direct contact with reagents. Direct contact may result in skin irritation or damage. Refer to the reagent kit box labels for specific instructions.
2. Avoid direct contact with CleanCell. Direct contact may result in skin irritation or damage. Refer to the CleanCell box label for specific instructions.

Additional Precautions

To Prevent Electrical Shock

1. Do not open the back cover. You may receive an electric shock.
2. Do not open the cover of the PMT high voltage supply circuit board with the power switch or circuit breaker turned on. Touching the board may cause death or severe injury.

Flammables

Avoid using dangerous flammables around the instrument. Fire or explosion may be caused by ignition.

Accuracy/Precision of Measured Results

For proper use of the instrument, measure control samples and monitor the instrument during operation.

An incorrectly measured result may lead to an error in diagnosis, therefore posing danger to the patient.

1.4 Potential Hazards and Safety Precautions

Application

The instrument is designed for clinical immunological test analysis using water-soluble samples and reagents.

Please note that other analyses may not be applicable to this instrument.

Operator Qualification

1. Operation should be conducted under the management of a technician who has undergone training at the facility specified by the sales agent.
2. For clinical tests, the instrument should be used under the management of a doctor or clinical inspector.

Operation and Maintenance

1. During operation and maintenance of the instrument, proceed according to the instructions and do not touch any parts of the instrument other than those specified.
2. Verify the front covers are closed while the instrument is in operation unless you load samples on the sample disk or A-Line or remove samples from the sample disk or C-Line.
3. Avoid touching the sample/reagent probe mechanism, sipper probe mechanism, gripper (tip/cup carrier) mechanism, mixing mechanism and other moving parts while the instrument is operating. Otherwise, the instrument may be damaged or operation may be stopped.
4. Avoid touching the sample disk or reagent disk while the instrument is in operation. Otherwise, the instrument may be damaged or operation may be stopped.
5. Do not use a cellular phone or a transceiver in the laboratory because it may interfere with the analyzer.

Installation Requirements

Installation is performed by a Roche Diagnostics representative. The customer is responsible for providing the necessary facilities as detailed in Section 2.7, Technical Data.

1.4 Potential Hazards and Safety Precautions

Restrictions on Samples and Reagent Solutions

1. The assay cups, assay tips, detection unit and liquid waste container or solid waste tray and liner are not guaranteed to be chemically resistant against organic solvents. Therefore, do not use organic solvents on these parts.
2. Avoid using sample and reagent solutions that are likely to adhere to the assay tips, assay cups, liquid waste container or detection unit.

Handling Reagent Solutions

Follow the manufacturer's instructions for use of a reagent solution.

Loading Samples and Reagents

Be sure to load samples and reagents only into the specified positions on the instrument.

If sample or reagent is spilled, this may cause a malfunction of the instrument.

Sample Disk

Verify sampling has stopped before you load additional samples on the sample disk or remove processed samples from the sample disk while the analyzer is in operation. Otherwise, the instrument may be damaged or operation may be stopped.

A-Line (rack system)

Verify that the light on the rack sampler is green, prior to adding a new rack or tray to the A-Line or removing a tray of processed samples from the C-Line while the analyzer is in operation. Otherwise, the instrument may be damaged or operation may be stopped.

Microparticle Mixer

Be careful not to bend the microparticle mixer. A bent mixer could lead to inaccurate results.

Switching On the Instrument

Never switch on the power within one second of switching it off.

1.4 Potential Hazards and Safety Precautions

Instrument Unused for a Long Time

If the instrument will not be used for a long period of time (i.e., > 7 days), contact Technical Support. Different shutdown procedures are recommended depending upon the duration of inactivity. In addition, certain procedures require the assistance of a Roche Diagnostics service representative.

Reagent Disk

Verify the reagent disk cover is locked on the reagent disk unless you are exchanging reagents.

Approvals

The Elecsys 2010 analyzer was manufactured and tested according to international standard IEC 1010-1 “Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1: General requirements”. This international standard is equivalent to the national standard Underwriters Laboratories (UL) 3101-1. The Elecsys 2010 analyzer bears the following safety marks, which appear on a single label on the right side of the analyzer.

The analyzer was tested and approved by the VDE and UL and received the following safety marks:

issued by VDE Testing and Certification Institute, Association of German Electrical Engineers (VDE)

issued by Underwriters Laboratories, Inc. (UL)

issued by Underwriters Laboratories, Inc. for Canada as a Certification and Testing Organization by the Standards Council of Canada (SCC).

the analyzer complies with the European Union (EU) directive 89/336/EEC (Electromagnetic Compatibility).

Notes

Chapter 2

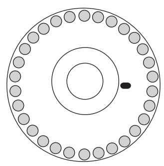
System Description

2.1 System Description

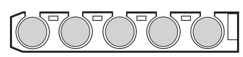
Introduction

The Roche Diagnostics Elecsys 2010 Immunoassay System is a fully automated, software-controlled system for immunoassay analysis. It was designed for both quantitative and qualitative in vitro determinations using a large variety of tests for analysis.

To assist you in quickly identifying which component is specific to either the disk or rack system, one of the following graphics appears in the to the right of the subsection header. If no graphic appears next to the header, then that component is common to both systems.



Disk



Rack

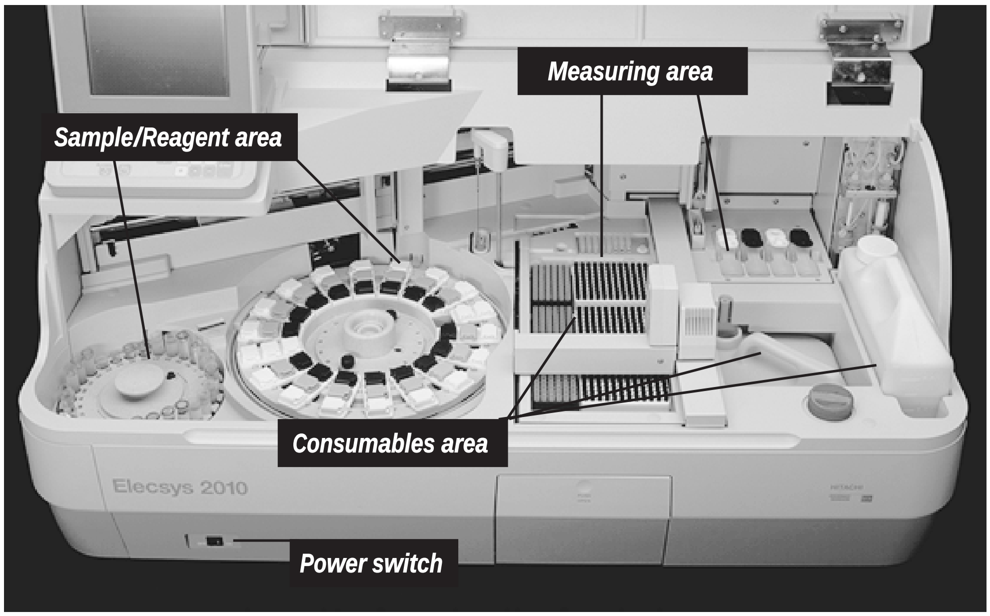
The Control Unit

The control unit, consisting of a touchscreen monitor and a keyboard, is located on the left of the analyzer. Also included as part of the control unit is the floppy disk drive, located inside the door above the solid waste tray.

The touchscreen and keyboard can also be removed from the shelf on the analyzer and placed on the laboratory bench top.

Control unit

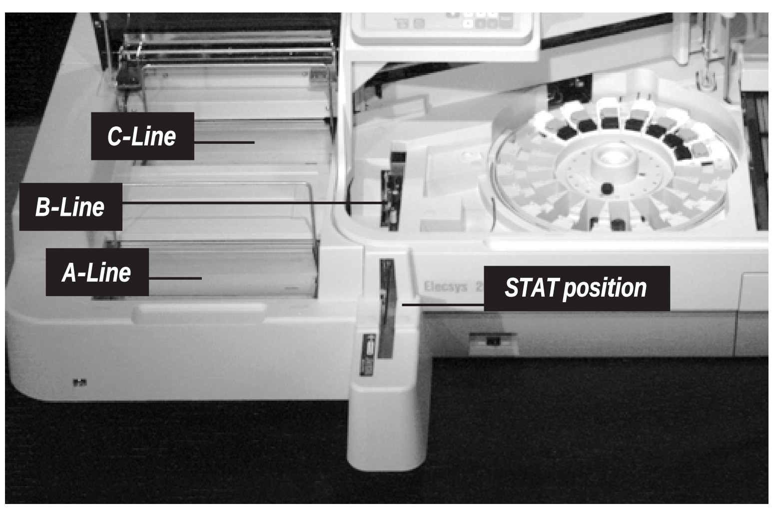
The Analyzer Unit



The analyzer unit on the disk system consists of the:

- sample/reagent area
- consumables area
- measuring area
- power switch.

The only difference on the rack system is in the sample area. The sample disk is replaced by a rack sampling unit. Refer to the photo below.



2.1 System Description

Sample/Reagent Area

The sample/reagent area comprises the left half of the analyzer and consists of a sample disk or rack sampler (rack system), rack bar code reader (rack system), sample/reagent (S/R) probe, bar code reader, bar code card reading station, reagent disk, a cap open/close mechanism, a microparticle mixer, probe/mixer rinse station and sample/reagent (S/R) pipettor.

The sample disk accommodates up to 30 samples. The A-Line of the rack sampler accommodates 75 samples on a single tray (15 racks at a time; each rack with five positions) and 25 samples in the input buffer for a total capacity of 100 samples. The reagent disk, temperature controlled at 20 ± 3 °C, accommodates up to 18 reagent packs.

Consumables Area

The consumables area is on the right of the analyzer, consisting of three tip trays, three assay cup trays, a gripper unit, cup disposal opening, liquid waste container, solid waste tray and liner and distilled water container.

Measuring Area

The measuring area includes the incubator, the sipper probe, sipper rinse station, system reagents (ProCell and CleanCell), an aspiration station, sipper pipettor and the detection unit. The sipper probe aspirates the incubated reaction mixture into the detection unit for result determination.

Power Switch

The operation ON/OFF switch is located on the front left of the analyzer. In addition, there is a circuit breaker for the analyzer located on the right rear of the analyzer and a rack sampler circuit breaker located on the left side of the rack sampler.

2.2 Control Unit Components

Introduction

The control unit consists of a color touchscreen monitor, a keyboard, floppy disk drive unit and an external printer.

Touchscreen Monitor

The touchscreen monitor is located on the left of the analyzer and displays the software. The Elecsys 2010 software displays menu items as folders. Each folder is accessed by touching the corresponding folder tab.

Touchscreen monitor

Keyboard

Keyboard

The 2010 keyboard consists of global action keys, navigation keys and numeric keys. These keys are described in detail in the Section 1.1, Software Basics – *Software Guide*.

2.2 Control Unit Components

Floppy Disk Drive

The floppy disk drive is located behind the front access door above the solid waste tray. The drive holds a data disk required for analyzer operation.

Floppy disk drive

Data Disk

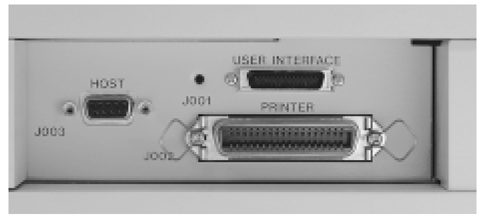
The data disk contains a number of files necessary for the analyzer and the software to work together. These files include:

- assay reference tables: these tables contain information that is linked to data encoded in the reagent bar code (e.g., test number, test code, available units and unit conversion factors).
- calibration data
- result messages
- total number of determinations per reagent pack (i.e., 100 or 200)
- orders and test results (up to 600 can be stored)
- all instrument adjustments
- serial number of analyzer (entered by Service during software installation).

It is important to keep each data disk with its analyzer. Using a data disk containing adjustments from a different analyzer results in mechanical movement errors. Use of an incorrect data disk causes alarm 57-01-01: Serial no. check error to occur.

External Printer

The instrument uses an 80-column, graphics-capable, dot matrix printer. Patient results can be printed in single or multiple report format, which uses less paper. Examples of each printed report are found in Chapter 8 of the Software Guide.



Location of the printer port

The printer is connected to the analyzer via a parallel printer port. The port is located on the left side of the analyzer directly below the touchscreen cable port.

Host Interface

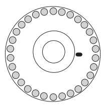
The instrument can be bidirectionally interfaced with a host computer. Details concerning the interfacing of the 2010 analyzer are available by contacting Technical Support.

2.3 Sample/Reagent Area Components

Introduction

The sample/reagent area consists of a sample disk or rack sampler (rack system), rack ID bar code reader (rack system), sample/reagent (S/R) probe, bar code reader, bar code card reading station, reagent disk, cap open/close mechanism, microparticle mixer, probe/mixer rinse station and sample/reagent (S/R) pipettor.

Sample Disk



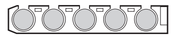
The sample disk has 30 positions for samples, calibrators and controls. Patient samples may be placed in either primary sample tubes or sample cups. Built-in adapters allow intermixing of different size primary sample tubes. The following is a list of the available primary sample tubes that may be used on the sample disk:

- 13 x 75 mm
- 13 x 100 mm
- 13.25 x 78 mm
- 14.0 x 100 mm
- 15.3 x 75 mm
- 15.65 x 100 mm
- 16 x 75 mm
- 16 x 100 mm
- 16.2 x 100 mm
- 16.5 x 92 mm.

Sample disk

Sample cups [2 ml (Standard) Hitachi cups **only**] may be placed directly on the sample disk or on top of 16 mm primary sample tubes.

Micro cups cannot be used on the 2010 analyzer!

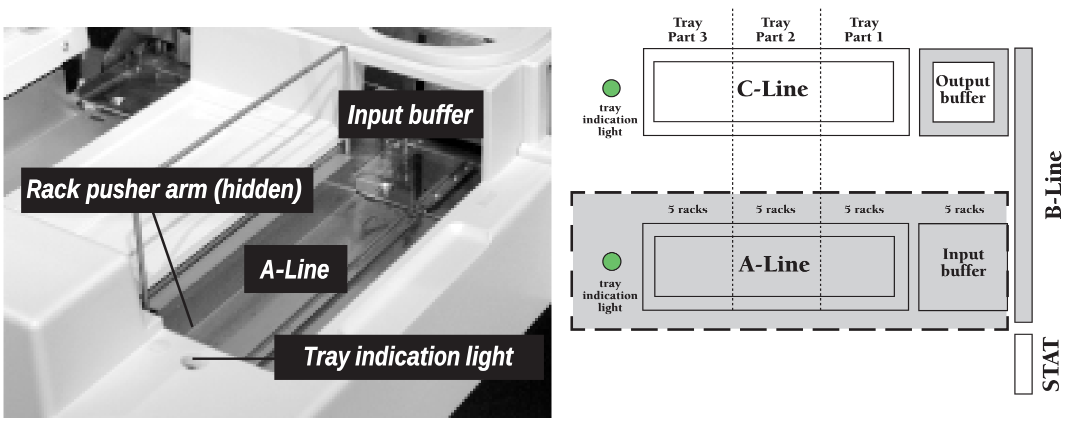
Rack Sampler 

The rack sampler consists of an A-Line, B-Line, C-Line and STAT position.

A-Line

Specimens are placed in 5-position sample racks and are loaded onto a tray. Once a tray is loaded, additional racks can be added to the tray one at a time during operation, provided the tray indication light is green (ON). If the light is out (OFF), the pusher arm is preparing to move. The pusher arm is located at the far left of the A-Line and pushes the sample racks forward and onto the B-Line.

The A-Line holds a tray that accommodates 15 racks at one time. Another five racks can be in the input buffer. Therefore, you can have a total of 100 specimens loaded at any one time. Refer to the photo and graphic below.

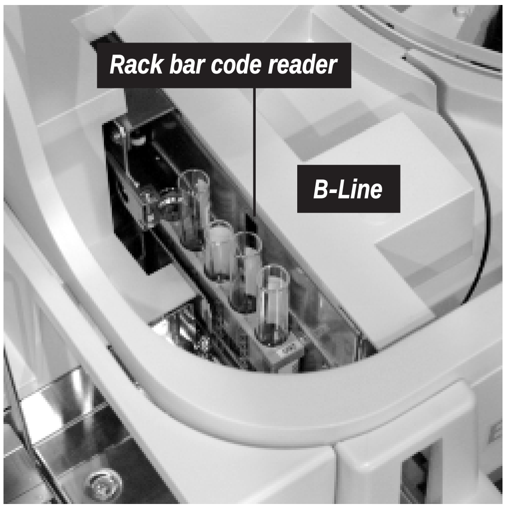


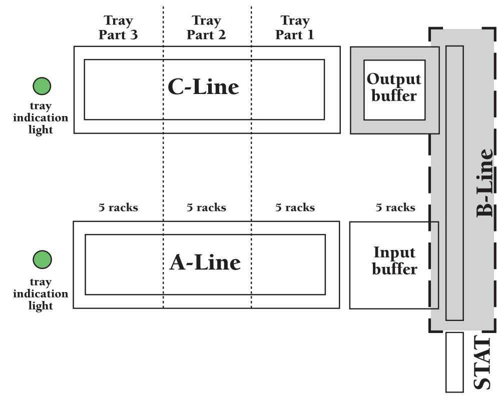
A-Line of the rack sampler

2.3 Sample/Reagent Area Components

B-Line

The B-Line transports the sample racks, single file, first to the rack bar code reader. Here each position in the rack is scanned for a sample bar code. After the last position is scanned, the bar code reader scans the rack ID. After the last specimen is sampled, the rack is transferred to the output buffer of the C-Line. Refer to the photo and graphic below.





B-Line of the rack sampler

Rack Bar Code Reader

The rack bar code reader reads both sample bar code labels and the rack bar code label. The bar code reader is auto-discriminating, allowing the use of various types of bar codes during operation. Bar code symbologies read include:

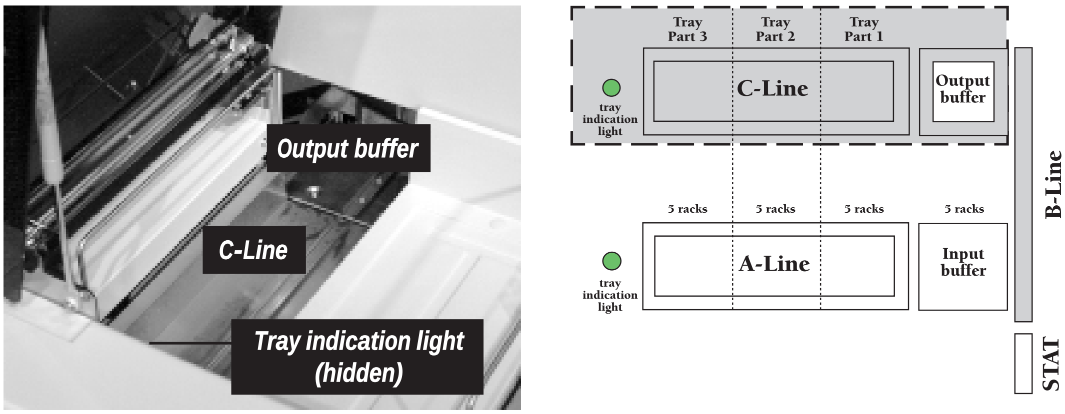
- NW7 (Codabar)
- Code 39
- Code 128
- Interleaved 2 of 5.

Rack bar code reader

C-Line

Racks are off-loaded from the B-Line into the output buffer. Like the input buffer, this space holds five racks. When the sixth rack is moved into the output buffer, a rack is pushed onto the tray on the C-Line. You can remove the tray from the C-Line any time the tray indication light is green (ON). If the light is out (OFF), the system is preparing to push a rack onto the C-Line tray. You cannot remove single racks from the C-Line. You must remove an entire tray at one time.

If the tray is removed, the system continues to push racks into the output buffer. If the buffer fills and there is no tray, the analyzer issues an alarm and stops sampling racks.



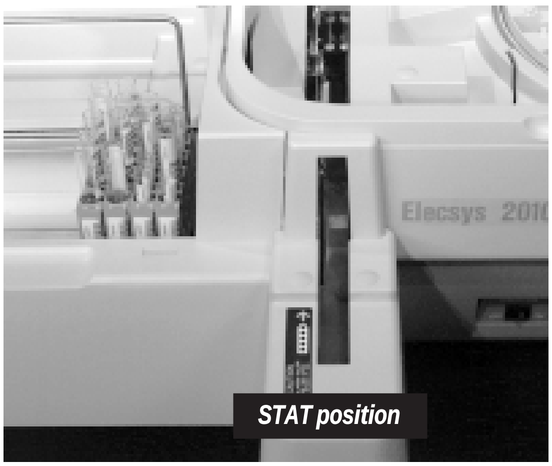
C-Line of the rack sampler

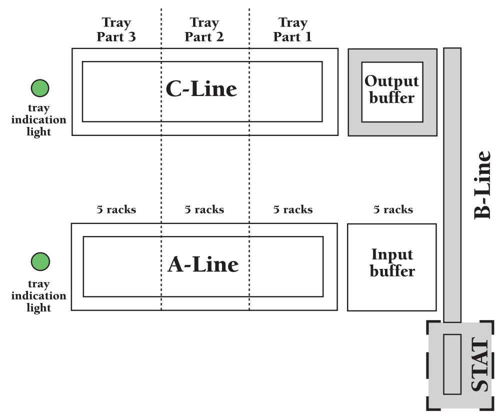
Output buffer with racks

2.3 Sample/Reagent Area Components

STAT Position

The STAT position is located at the front of the analyzer and is in line to feed directly onto the B-Line. Place a rack in the position as directed on the label and press the key. When the rack currently being sampled is completed, the STAT rack is pushed onto the B-Line and is sent on to the rack bar code reader and sampling position.

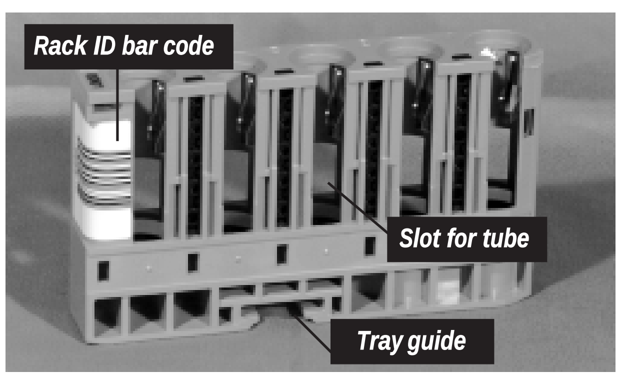




STAT position of the rack sampler

Sample Rack

Sample cups, primary sample tubes, calibrator or control vials are placed in sample racks shown below. Each sample rack holds a maximum of five samples. Each tube slot contains adapters that allow the rack to hold different sizes of primary sample tubes. Each rack has a unique ID found on the bar code label on the back end of the rack. This rack ID is read by the bar code reader and transferred to the system. This ID appears on the screens in the software and on the reports.

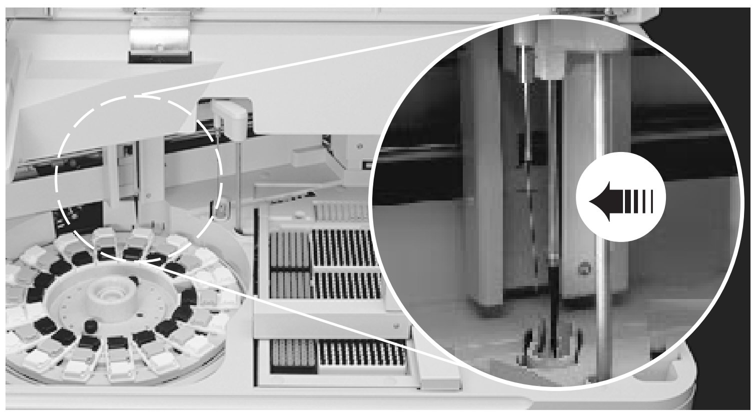


Sample rack

Sample/Reagent (S/R) Probe

The sample/reagent probe is located on the back left wall of the analyzer and is mounted on an arm (S/R arm) that moves horizontally between the sample and reagent disk. The probe uses disposable tips to control sample carryover, and has liquid level and clot detection for accurate pipetting. Liquid level detection is accomplished by capacitance measurement. Clot detection is accomplished by a pressure transducer.

A new assay tip is utilized with every new pipetting sequence. For example, TSH = 1 tip for R1, R2 and sample, then one new tip for microparticles. The tip is washed externally at the rinse station between each aspiration. Additional tips are used for sample dilutions or pretreatment.



S/R probe with tip

2.3 Sample/Reagent Area Components

Bar Code Reader

During a sample scan, the bar code reader scans the information on the bar code-labeled primary sample tubes, calibrators or controls, and transmits it to the software. During a reagent scan, the reader rotates to the reagent disk side to read the 2-dimensional bar code labels on the reagent packs.

The bar code reader is located toward the back wall of the analyzer.

On the disk system:

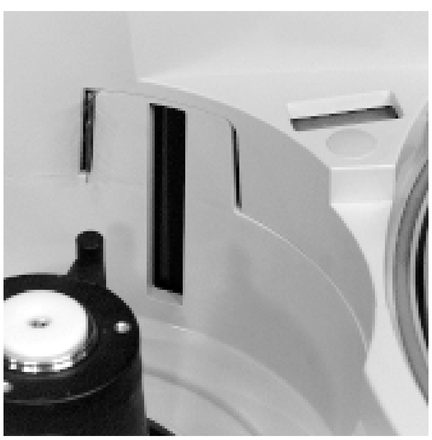
- it can be seen when either the sample disk or reagent disk is removed.
- to read bar code labels, the bar code reader rotates between the sample and reagent disks, and the card reading station.

On the rack system:

- it can only be seen when the reagent disk is removed.
- to read bar code labels, the bar code reader rotates between the reagent disk and the card reading station.

The bar code reader is auto-discriminating, allowing the use of various types of bar codes during operation. The bar code symbologies read include those previously described in the rack bar code reader subsection. In addition, this bar code reader also reads PDF417.

PDF417 can only be used for reagent bar codes and bar code cards.



Bar code reader (sample disk side)

Bar code reader (reagent disk side)

Bar Code Card Reading Station

At this station, the bar code reader scans calibrator and control information from the calibrator or control bar code card. These cards are packed in calibrator or control kits.

On the disk system:

- it is located between the sample disk and reagent disk.

On the rack system:

- it is located to the back left of the reagent disk.

Bar code card reading station

Reagent Disk

The reagent disk contains 18 positions for assays, diluent or pretreatment reagent. A maximum of 15 assays can be loaded on the disk at one time. The reagent disk is temperature controlled at 20 ± 3 °C.

Diluent or pretreatment reagent can be placed in ANY position on the reagent disk. Any additional reagent packs placed on the disk must be for one of the 15 assays currently on the reagent disk. For example, you may have the maximum of 15 assays occupying the 18 available disk positions, or you may have only a few assays divided amongst the 18 available disk positions.

Reagent disk

2.3 Sample/Reagent Area Components

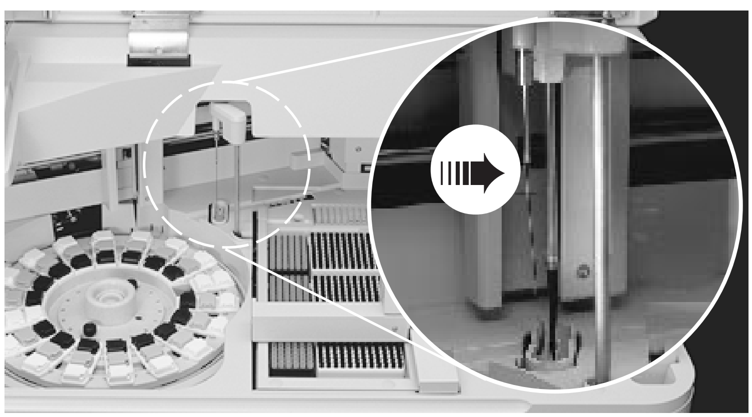
Reagent Cap Open/Close Mechanism

To prevent reagents from evaporating, and to promote ease of use for the operator, the reagent disk utilizes a reagent cap open/close mechanism during reagent pipetting. The mechanism is located on the back wall of the reagent disk compartment and emerges when reagents need to be opened or closed. Caps are opened prior to pipetting or mixing the specific reagent (e.g., R1, R2 or M) and are closed when pipetting or mixing for the specific reagent (e.g., R1, R2 or M) is completed.

Reagent cap open/close mechanism

Microparticle Mixer

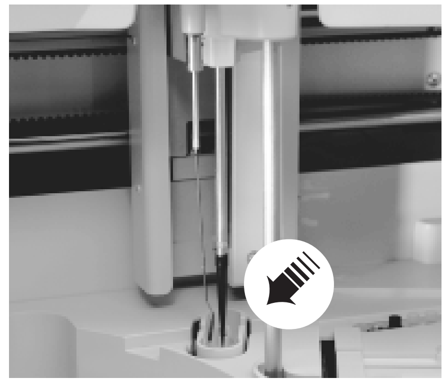
The mixer is utilized to mix the microparticles to ensure a homogenous suspension before aspiration. The mixer is located to the right of the reagent disk. In its home position, it occupies the space directly to the left of the S/R probe.



Microparticle mixer

Probe/Mixer Rinse Station

The rinse station rinses the assay tip or mixer externally with deionized water between aspirations, or before and after microparticle mixing. The rinse station is located below the S/R probe and mixer when the probe is in its Stand-by position and the mixer is in its home position.



Rinse station

Sample/Reagent (S/R) Pipettor

The S/R pipettor is located on the back right of the analyzer. The pipettor is filled with deionized water and uses positive displacement to aspirate and dispense from the S/R probe.

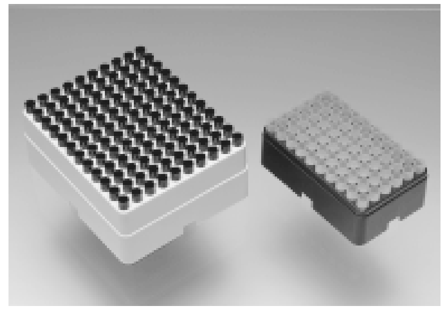
Sample/reagent pipettor

2.4 Consumables Area Components

Introduction

The consumables area consists of three assay cup trays, three tip trays, gripper, incubator, cup disposal opening, pipetting station, liquid waste container, distilled water container and solid waste tray and liner.

One tip tray holds up to 120 tips, and one cup tray holds up to 60 cups. Therefore, a total of 360 tips and 180 cups can be placed on the analyzer.



Tip tray and cup tray

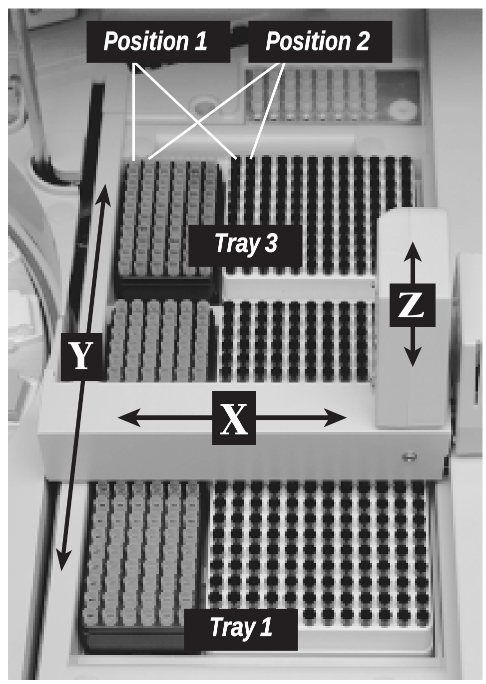
Gripper

The gripper can move in three directions:

- X (left and right)
- Y (forward and back)
- Z (up and down).

It is also equipped with gripping fingers for gripping a tip or assay cup. The gripping fingers grip a tip from the tip tray, or a cup from the cup tray and deliver it to the pipetting station. Then, at the appropriate time, the gripper moves the assay cup to the incubator, then to the aspiration station, and finally to the cup disposal opening.

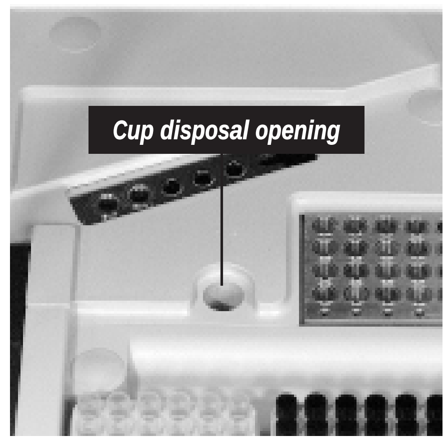
During operation, the analyzer starts utilizing tips and cups from tray 1, position 1. As soon as tray 1 is empty, the analyzer starts using tray 2. As soon as tray 2 is empty, the analyzer continues with tray 3. When tray 3 is empty, the analyzer returns to tray 1.



Gripper and trays

Cup Disposal Opening

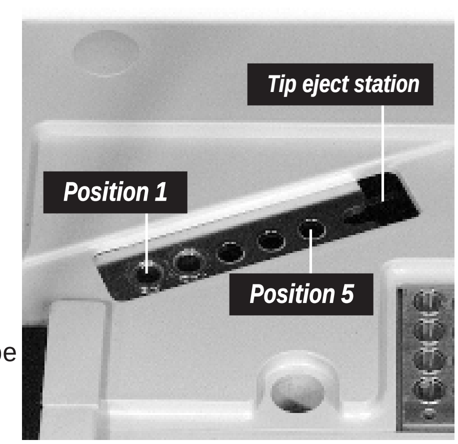
Assay cups are discarded through a cup opening located directly to the left of the incubator.



Cup disposal opening

Pipetting Station

A five position pipetting station is located to the upper left of the incubator. Assay cups and tips are moved by the gripper to this location for sample and reagent pipetting, sample dilution and sample pretreatment. The assay tips are discarded at the tip eject station at the far right of the station. Positions 1 and 2 are used for tips and positions 3 and 4 are used to hold cups for dilution or pretreatment. Position 5 is the position where the S/R probe pipettes sample and reagent.



Pipetting station

2.4 Consumables Area Components

Distilled Water Container

The distilled water container is located in front of the pipettors and to the right of the liquid waste container. It holds three liters of distilled water. An alarm is issued when the distilled water container is empty. A float mechanism sensor located beneath the aspiration inlet, triggers the alarm on the INVENTORY screen.

Removing the distilled water container during operation causes the analyzer to enter P. Stop status.

Distilled water container

Liquid Waste Container

The liquid waste container is located in front of the ProCell and CleanCell reagents. It holds four liters of waste and issues an alarm when approximately three-quarters full. The alarm is triggered by a weight-sensitive mechanism that activates a photosensor located in the compartment holding the container. An alarm is also issued when the container is improperly positioned. This alarm is triggered by a plate mechanism that activates a photosensor located at the front of the compartment.

Removing the liquid waste container during operation or an improperly positioned container causes the analyzer to enter E. Stop status.

Liquid waste container

Solid Waste Tray and Liner

The solid waste tray and liner is located behind the front access door on the analyzer. Used assay cups and tips are discarded into the waste tray during operation.

Solid waste tray and liner

A disposable liner (Clean-Liner) made of polystyrene is placed inside the solid waste tray. The Clean-Liner has a sliding cover to reduce potential splashing and to prevent tips and cups from falling out of the tray upon removal from the analyzer. During operation, the sliding cover must be open. The tray shakes periodically during operation so that used tips and cups do not accumulate at one end of the tray.

An alarm is issued when either the tray is full or if the tray and liner are missing. The presence of a tray is monitored by a photosensor.

Removing the solid waste tray during operation causes the analyzer to enter E. Stop status.

2.5 Measuring Area Components

Introduction

The measuring area includes the incubator, aspiration station, sipper probe, sipper rinse station, sipper pipettor, system reagents (ProCell and CleanCell) and the detection unit.

Incubator

The incubator is maintained at a specific temperature (37.0 °C ± 0.3 °C) for the reaction of the sample and the reagents that have been dispensed into a cup. The incubator is equipped with 32 positions.

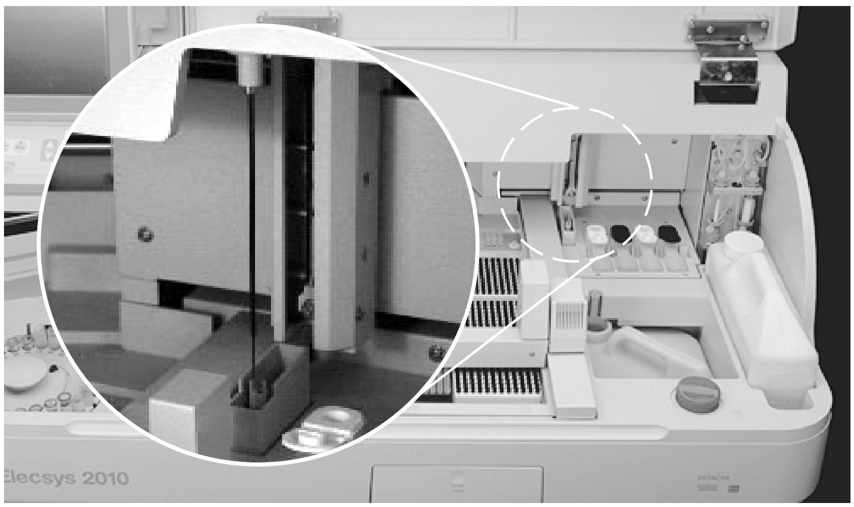
When an assay is ready for measurement, the assay cup is transferred by the gripper to the aspiration station, and the sipper probe aspirates the reaction mixture for measurement. The aspiration station, located in the lower right corner of the incubator, is not temperature controlled.

Incubator

Sipper Probe

The sipper probe aspirates the reaction mixture into the measuring cell. ProCell and CleanCell are also aspirated by the sipper probe. The sipper probe is located to the right of the incubator.

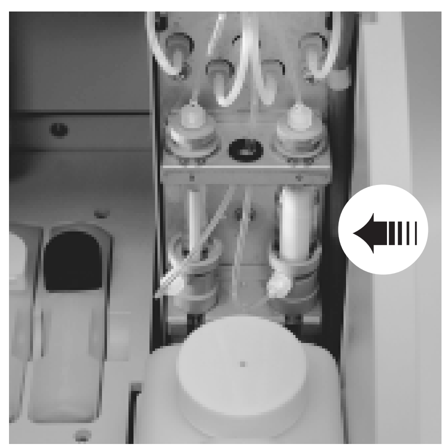
The sipper rinse station externally washes the sipper probe with distilled water between measurements. When the sipper probe is in its Stand-by position, the probe is located directly above the rinse station.



Sipper probe and rinse station

Sipper Pipettor

The sipper pipettor is located directly to the right of the sample/reagent pipettor. It uses positive displacement of water to aspirate and dispense from the sipper probe.



Sipper pipettor

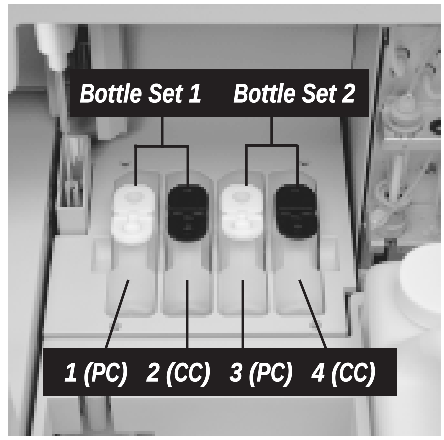
2.5 Measuring Area Components

System Reagents (ProCell and CleanCell)

ProCell and CleanCell are located behind the liquid waste container. ProCell is the buffer solution containing tripropylamine (TPA). These bottles are identified with white caps.

CleanCell is the cleaning solution used to clean the measuring cell after measurement. CleanCell bottles are identified with black caps.

The reagent compartment is keyed to ensure the correct reagent is placed in the proper position. Two bottles of each reagent are stored on the analyzer, temperature controlled at 28.0 °C ± 2.0 °C.



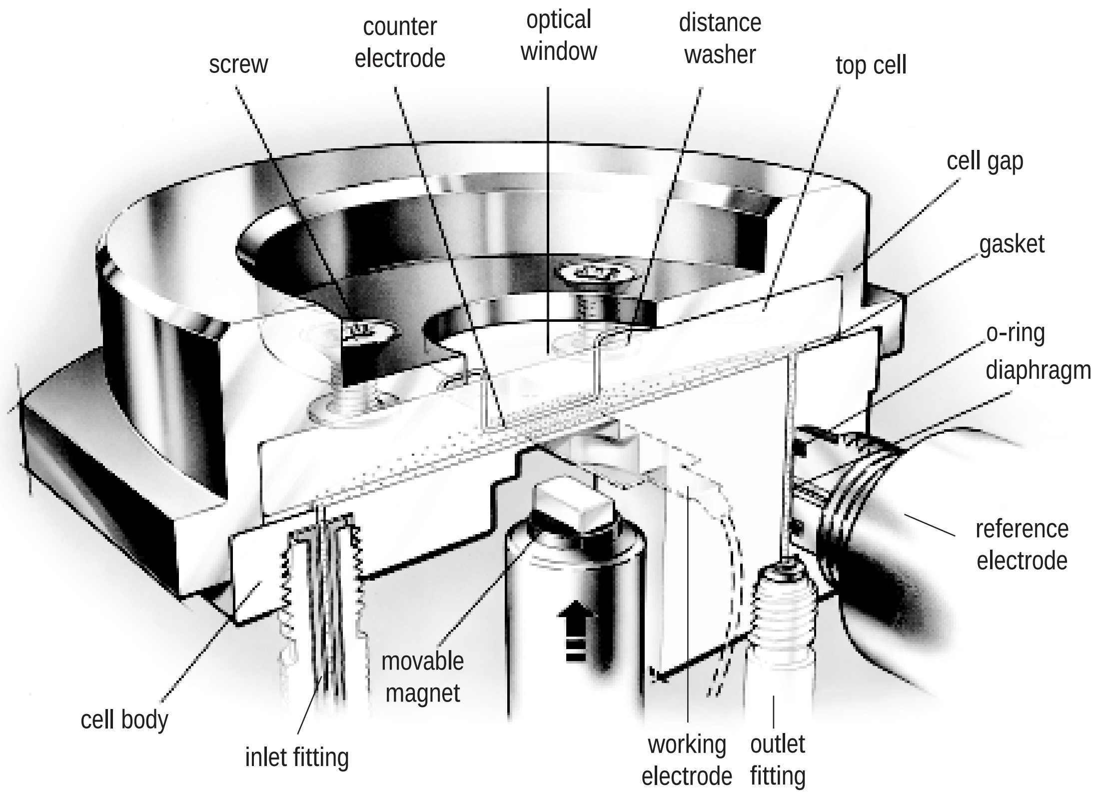
ProCell (PC) and CleanCell (CC)

When starting from Stand-by, the sipper probe always attempts to first use ProCell and CleanCell from bottle set 2. If the quantity is insufficient, bottle set 1 is used. When starting from S. Stop or R. Stop, the bottle set in use when the analyzer was previously in Operation is pipetted. When the volume of that bottle set becomes insufficient, the sipper probe changes to the other bottle set.

The analyzer can operate with one bottle set of ProCell and CleanCell reagent, but they must be placed in positions 1 & 2 or 3 & 4. Refer to the photograph above.

Detection Unit

The detection unit is the core of the Elecsys 2010 system. The detection unit contains the photomultiplier tube, peltier, flow-through measuring cell, magnet drive assembly and an amplifier circuit board. The temperature is maintained at 28.0 °C ± 0.5 °C.



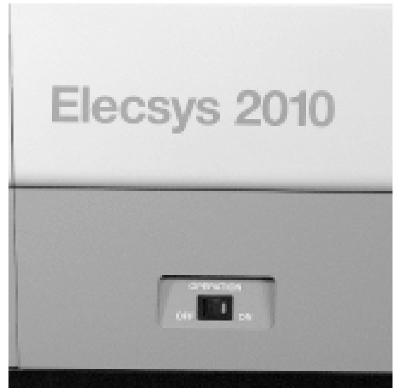
Measuring cell of the detection unit

2.6 Power Components

Operation ON/OFF Switch

The operation ON/OFF switch is located on the lower left front side of the analyzer. Use this switch to turn OFF the analyzer to perform certain maintenance procedures or when the system is not in use for extended periods of time (e.g., overnight). The operation switch also turns OFF the power to the touchscreen.

Provided the circuit breaker is ON, the reagent disk and system reagent compartment temperatures are maintained while the operation switch is OFF.



Operation ON/OFF switch

Circuit Breaker

The circuit breaker is located on the right side panel of the analyzer above the power supply cord. The circuit breaker controls the power supplied to the temperature controlled reagent compartments when the operation switch is OFF. The circuit breaker must be in the “I” (ON) position whenever reagents are stored on the analyzer and to maintain liquid in the measuring cell.

To disconnect the analyzer from the supply source, the circuit breaker must be in the “O” (OFF) position and the power cord must be removed.

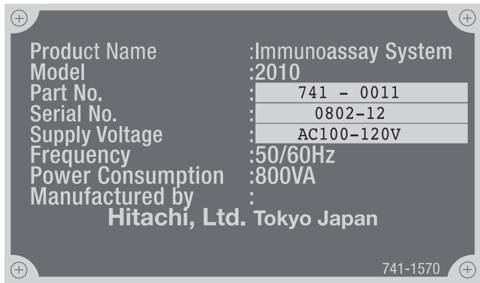
Circuit breaker

Rack Circuit Breaker

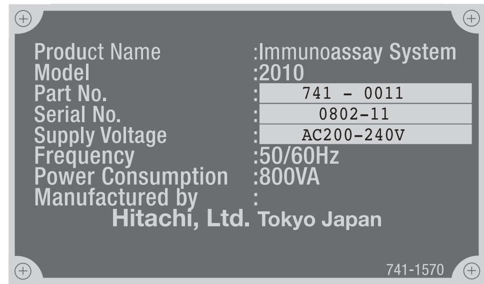
There is a circuit breaker located on the left side of the rack sampler. This controls power to the sampler unit. The circuit breaker should be kept in the “I” (ON) position at all times. Use the operation switch to power ON and OFF the rack system.

To disconnect the analyzer from the supply source, the circuit breaker must be in the “O” (OFF) position and the power cord must be removed.

Rack circuit breaker

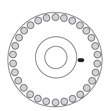
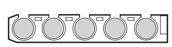


Analyzer plate (US)



Analyzer plate (Europe)

Instrument Dimensions

Analyzer	Height	Depth	Width	Weight
	22.05 in (56 cm) [not including the touchscreen]	28.7 in (73 cm)	47.2 in (120 cm)	~ 375 # (170 kg)
	22.05 in (56 cm) [not including the touchscreen]	37.5 in (95 cm)	67.2 in (170 cm)	~ 462 # (210 kg)

Electrical

Installation requirements	Pollution degree: 2 (IEC 1010-1) Overvoltage category: II (IEC 664) The Elecsys 2010 analyzer must be connected to a three-wire power supply cord with a safety ground.
Supply voltage/frequency	100-120 VAC 50/60 Hz single phase or 200-240 VAC 50/60 Hz single phase The range of supply voltage and frequency should only be configured to laboratory specifications by Roche Diagnostics service personnel.
Power consumption	800 VA
Heat generation	approx. 2,879 kJ/hr resp. 688 kcal/hr resp. 2,730 Btu/hr

2.7 Technical Data

Environmental Conditions

Temperature	18 °C to 32 °C 64.4 °F to 89.6 °F
Temperature variation	Max. ± 2 °C/hour Max. ± 3.6 °F/hour
Humidity	20% to 80%

Noise Level (DIN 43635)

Stand-by level	60 dBA
Operation level (average)	63 dBA
Operation level (maximum)	70 dBA

Water Supply

Water container	3 Liters
Water requirements	< 10 µS/cm or > 0.1 megohm, bacteria-free
Water consumption	approx. 3 L for 250 tests approx. 12 mL/cycle

Liquid Waste

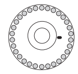
Liquid waste container	4 Liters

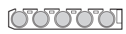
Throughput Rate

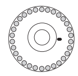
Assay measurements	approx. 86 tests/hour

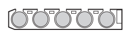
Sampling System

Sample/Reagent pipettor principle	conductive disposable tip handling
Sample/Reagent pipettor precision	< 1.5% CV at 10 µL < 1% CV at 50 µL
Sample volume per test	10 µL to 50 µL
Sample detection	Liquid level detection and clot detection

Sample loading capacity  30 positions for samples, controls and calibrators

 ***tray*** – 15 racks with 5 positions each for samples, controls and calibrators = 75
tray with input buffer – 20 racks with 5 positions each = 100

STAT capacity  any unoccupied position on the sample disk

 STAT position at the front of the analyzer

Bar code symbologies
PDF417
NW7 (Codabar)
Code 39
Code 128
Interleaved 2 of 5

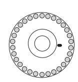
Assay tips: 360 tips (3 trays; 120 tips/tray)

Assay cups: 180 cups (3 trays; 60 cups/tray)

Sample cups: 2 mL (Standard) Hitachi cup; **NO micro cups**

Primary sample tubes

13 x 75 mm	15.65 x 100 mm
13 x 100 mm	16 x 75 mm
13.25 x 78 mm	16 x 100 mm
14.0 x 100 mm	16.2 x 100 mm
15.3 x 75 mm	16.5 x 92 mm

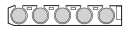
Sample container dead volume 

Sample Container	Tube height	“Normal” dead volume	“Reduced” dead volume
standard Hitachi cup directly on the sample disk	—	250 µL	100 µL
standard Hitachi cup on top of a primary sample tube (d* = 16 mm)	75 mm	250 µL	150 µL
standard Hitachi cup on top of a primary sample tube (d* = 16 mm)	100 mm	200 µL	100 µL
primary sample tube (d* = 13 mm)	75 mm	600 µL	—
primary sample tube (d* = 13 mm)	100 mm	600 µL	—
primary sample tube (d* = 16 mm)	75 mm	1000 µL	—
primary sample tube (d* = 16 mm)	100 mm	1000 µL	—
calibrator/control vial	—	250 µL†	250 µL†

* “d” represents the outside diameter of the sample tube.

† The button displays “BM bottle” rather than “Normal” or “Reduced.”

2.7 Technical Data

Sample container dead volume 

Sample Container	Tube height	"Normal" dead volume	"Reduced" dead volume
standard Hitachi cup directly on the sample rack	—	200 µL	100 µL
standard Hitachi cup on top of a primary sample tube (d* = 16 mm)	75 mm	250 µL	100 µL
standard Hitachi cup on top of a primary sample tube (d* = 16 mm)	100 mm	150 µL	100 µL
primary sample tube (d* = 13 mm)	75 mm	600 µL	—
primary sample tube (d* = 13 mm)	100 mm	600 µL	—
primary sample tube (d* = 16 mm)	75 mm	1000 µL	—
primary sample tube (d* = 16 mm)	100 mm	1000 µL	—
calibrator/control vial	—	250 µL†	250 µL†

* "d" represents the outside diameter of the sample tube.

† The button displays "BM bottle" rather than "Normal" or "Reduced."

Reagent System

Reagent disk temperature	20 °C ± 3 °C
Reagent capacity	15 assays in 18 reagent positions
R1/R2 consumption	50 to 80 µL per reagent dependent upon the assay
Microparticle consumption	30 to 50 µL dependent upon the assay
Reagent detection	liquid level detection
Positive reagent identification	2-dimensional bar code (PDF417)
Automatic dilution	available up to 1:100
Evaporation protection	reagents are automatically opened and closed
Inventory control	automatic based on counting (reagent disk) or liquid level detection (ProCell/CleanCell)

Incubation System

Incubator capacity	32 assay cups
Volume of assay cups	200 µL
Incubation temperature	37.0 °C ± 0.3 °C

Measuring System

Measuring method	integral measuring of an electrochemiluminescent signal
Calibration mode	2-point calibration
Test protocols	26 test methods
ProCell consumption	approx. 2 mL per cycle
CleanCell consumption	approx. 2 mL per cycle

Control System

Floppy disk	3 1/2 inch / 1.44 MB / high density
Host interface	CCITT V. 24/RS-232-C (bidirectional) The host computer should comply with the requirements of IEC (950).
External printer	parallel (Centronics)
Optional module	Laboratory System Manager (LSM)
Touchscreen monitor	VGA - LCD with 640 x 480 pixel

Notes

Chapter 3

Mechanical Theory

3.1 Mechanical Theory

Introduction

The Elecsys 2010 analyzer automates the immunoassay reactions utilizing electrochemiluminescence (ECL). These reaction methods are described in detail in Chapter 4, ECL Technology. The individual test steps and how the system performs the necessary procedures are discussed here.

Test Protocols

There are 26 test protocols or test steps that can be used on the analyzer. These protocols are predefined by Roche Diagnostics for each test and cannot be changed by the operator.

General Assay Sequence

An immunological ECL test is made up of various pipetting steps, at least one incubation period and a measurement step. Generally at least three test components (sample, reagent and microparticles) are pipetted into an assay cup. After the appropriate incubation period, the reaction mixture is aspirated into the measuring cell where the measurement process takes place. Each of the required pipetting cycles is performed within a defined period (42 seconds).

The number of pipetting steps, as well as the make up of the reaction mixture are dependent on the test method (1 or 2 step test). For some methods, predilution with diluent and/or pretreatment with a special reagent is necessary. Thus the number of pipetting steps is increased.

After each pipetting step the sample/reagent (S/R) probe tip is cleaned and, if necessary, the microparticle mixer and sipper probe are also cleaned.

The following steps apply in principle to all methods. The sequence of the individual processes differ from test to test.

Preparative Operations

Once the analyzer's power is switched ON, the initialization process is started. During initialization, the mechanisms are reset to their home positions.

Run Operation

After the appropriate test selections are made in the software for patient samples, operation is started according to the predetermined test protocol for each assay selected. Initially, at least one reagent (R1 or R2) and the sample or microparticles (M) are aspirated one after another by the S/R probe. After each aspiration, the outside of the S/R probe tip is cleaned at the rinse station. The sample and reagents are dispensed into a new assay cup and the assay tip is ejected into the solid waste tray.

For some tests that require sample dilution or pretreatment, diluent or pretreatment reagent is pipetted together with sample into an assay cup. An aliquot of the diluted/pretreated sample is then dispensed with reagent into a second assay cup. Therefore, certain tests with predilution/pretreatment may require two or more assay cups. For additional information refer to Section 3.3, Dilution Steps.

Incubation at 37 °C

The incubation times are 4.5 or 9 minutes long, depending on the test. Some tests require only one incubation, whereas tests with pretreatment can require up to three incubation periods. During the incubation step(s) the immune complex products are formed.

If using an assay that requires pretreatment, the first incubation (9 minutes) is for sample and pretreatment reagent(s).

Additional Reagent Pipetting

Some assays (usually those with multiple incubation steps) require additional reagent pipetting. As in the initial reagent pipetting step, a new pipette tip is picked up prior to reagent aspiration. The S/R probe tip is washed at the rinse station after each liquid aspiration. The liquid is then dispensed into the corresponding assay cup where the sample and other liquids were dispensed in the first pipetting step. The probe rises while dispensing the reaction mixture back into the cup, thereby mixing the solution and accelerating the reaction in the cup. The pipette tip is ejected into the solid waste tray when pipetting is complete.

Second Incubation at 37 °C

If necessary, a second incubation step (4.5 or 9 minutes) occurs.

If using a pretreatment assay, the second incubation is similar to that described above for “First Incubation at 37 °C.”

Additional Reagent Pipetting (Pretreatment assays)

For pretreatment assays, reagent pipetting similar to that described above for “Additional Reagent Pipetting” occurs.

Third Incubation at 37 °C (Pretreatment assays)

If necessary, a third incubation step (9 minutes) occurs for pretreatment assays.

Reaction Mixture Aspiration and Measurement

In this process the sipper probe first aspirates ProCell (tripropylamine solution, TPA) to prepare the measuring cell. Then, the sipper probe aspirates the reaction mixture from the assay cup and transfers it to the measuring cell. The sipper probe is washed at the rinse station and ProCell is aspirated again to rinse away the unbound reagent and sample constituents. Next, the ECL reaction in the measuring cell occurs.

3.1 Mechanical Theory

Measuring Cell Cleaning and Results

Once the measurement is complete, the measuring cell is cleaned with CleanCell and prepared for a new measurement process.

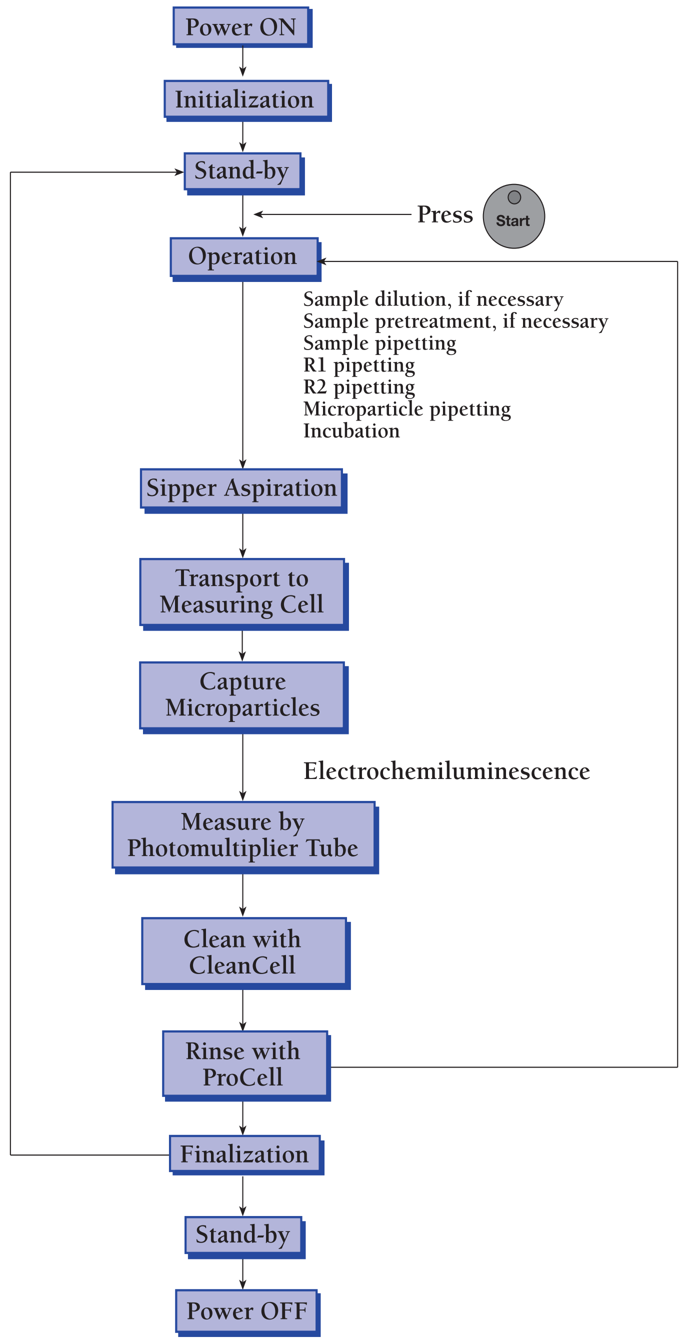
It takes 42 seconds (one pipetting cycle) from the aspiration of the reaction mixture by the sipper probe until the measuring cell is filled with ProCell and ready for the next sample.

Finalization

When all the requested tests have been performed, the sipper pipettor flushes deionized water through the sipper probe, and then fills the measuring cell with ProCell before the analyzer's status returns to Stand-by.

Operation Flow In Analysis

An operational flow chart is shown below.



Operational flow chart

3.2 Detailed Assay Sequence

Introduction

The mechanical process of the instrument is described below using a sandwich test, TSH, as an example. This example assumes that the reagent pack was already registered by the analyzer and does not need calibration. All results are calculated based on an existing lot calibration.

Preoperation Steps

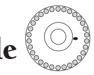
When Start is pressed from Stand-by, the following preoperative steps occur.

A. The analyzer resets all mechanisms to their respective home positions and accesses the data disk. Next, the S/R pipettor primes the S/R probe.

B. The gripper checks for a tip in position number 1 of the tip trays. If this position is empty, the gripper remembers where it last left off and checks that position. If this position is empty, the gripper considers the whole tray empty and the INVENTORY screen is updated accordingly.

If the analyzer is in S. Stop, the gripper remembers where it last left off and checks for a tip in that position.

1. During the tip check, the S/R probe is checked for the presence of a tip. The probe moves to the tip eject station and performs the movements to eject a tip. If a tip is present it is ejected.
2. After the tip check is complete, the assay cups are checked in the same manner. During the cup check, the analyzer finishes priming the probes.
3. Next, the gripper checks the last three of the five positions on the pipetting station.
   a. If a cup is present, the analyzer goes through the steps of a cup disposal. The gripper places a tip in position 1 of the pipetting station. Then, the S/R probe picks up the tip in position 1 of the pipetting station. The S/R probe descends into the assay cup and attempts to aspirate any possible liquid from the cup. The gripper picks up the cup and discards it into the cup disposal opening. As the cup is disposed, the S/R probe moves to the rinse station and dispenses any aspirated liquid. The tip is then washed and discarded.
4. The gripper moves to the incubator where it checks all 32 incubator positions. If a cup is present, the gripper moves the cup to position 5 on the pipetting station and uses the same procedure listed in step 3a to discard the cup.
5. The S/R probe tip is ejected after all the incubator positions are checked.

Dispense Reagent 1, Reagent 2 and Sample 

A TSH sample is present on position 1 of the sample disk.

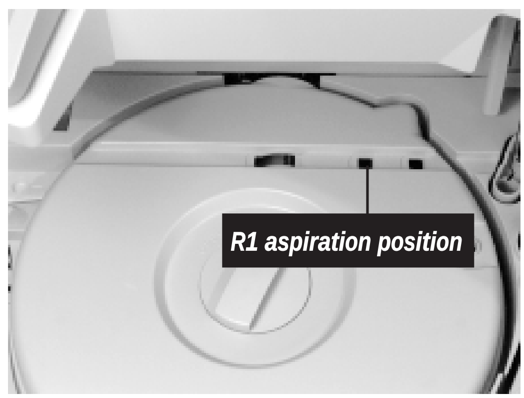
A. After preoperation functions are complete, the gripper takes a tip from the tip tray and transports it to position 1 of the pipetting station. The gripper returns to its Stand-by position.

B. The sample disk rotates until position 1 is in the sampling position.

C. The S/R probe moves to position 1 of the pipetting station, descends to obtain the tip, rises and returns to its Stand-by position.

D. During this time, the reagent disk rotates until the TSH reagent pack is at the cap open/close mechanism. The mechanism moves forward and opens the caps on the reagent pack. The disk rotates again to move the TSH reagent to the R1 position.

E. The S/R probe moves from its Stand-by position to the R1 aspiration position. While activating liquid level detection, the probe descends until it is 2 mm below the reagent surface and aspirates 60 µL of R1.



The lowest allowable point the S/R probe can descend to is 1.3 mm above the bottom of the reagent pack.

1. While aspirating R1, the gripper puts another tip in position 1 of the pipetting station.

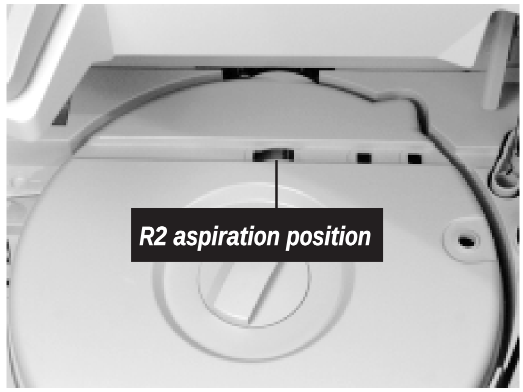
F. If the S/R probe does not detect liquid during descent, no reagent aspiration can occur. Alarm 37-01-02 (Assay reagent short) is generated.

G. After R1 aspiration, the S/R probe rises and moves to the rinse station. To prevent the aspirated R1 from contacting the water in the rinse station, the probe aspirates 10 µL of air. The rinse station externally washes the tip.

H. During step G, the reagent disk rotates until the TSH reagent pack is in the R2 position.

3.2 Detailed Assay Sequence

I. The S/R probe moves from the rinse station to the R2 position while aspirating another 10 µL of air. This air layer prevents R1 from mixing with R2. While activating liquid level detection, the probe descends until it is 2 mm below the reagent surface and aspirates 50 µL of R2.

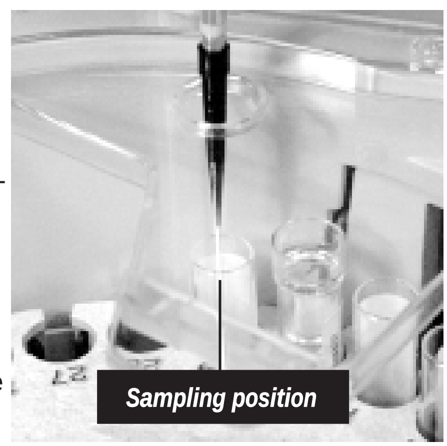


1. While aspirating R2 the gripper moves an assay cup to position 5 of the pipetting station.

J. Upon completion of R2 aspiration, the S/R probe rises and moves to the rinse station. To prevent the aspirated R2 from contacting the water in the rinse station, the probe aspirates another 10 µL of air. The rinse station externally washes the tip.

K. After R2 aspiration, the reagent disk rotates until the TSH reagent pack is at the cap open/close mechanism. The mechanism moves out and closes the caps.

L. The S/R probe moves from the rinse station to the sampling position while aspirating another 10 µL of air. While activating liquid level detection, the probe descends until it is 2 mm below the sample surface and aspirates 50 µL of sample. During sample aspiration, clot detection is activated.



M. The S/R probe moves from the sampling position to position 5 of the pipetting station. The probe descends until the tip reaches 2 mm below where the calculated level of the reaction mixture surface should be and dispenses the sample, R2 and R1. The probe's downward displacement is determined by calculating the reaction mixture volume for the sample and utilizing downward displacement tables in the software. The probe does not rise during dispense.

N. After dispense, the S/R probe moves to the tip eject position and ejects the tip.

Dispense Reagent 1, Reagent 2 and Sample

A TSH sample is present on position 1 of the sample rack.

A. After preoperation functions are complete, the gripper takes a tip from the tip tray and transports it to position 1 of the pipetting station. The gripper returns to its Stand-by position.

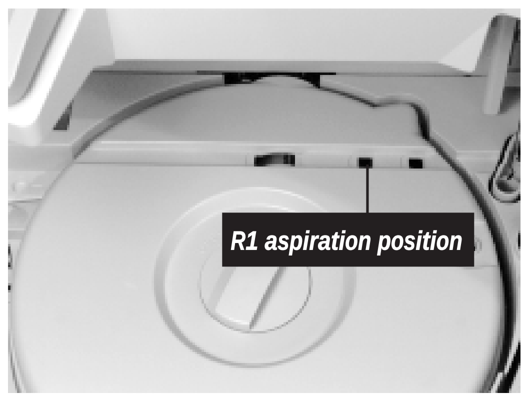
B. The pusher arm pushes the racks in the A-Line forward to the B-Line. The arm returns to its home position. The first rack loads on the B-Line.

C. As the rack incrementally moves on the B-Line, the rack bar code reader scans all five rack positions and rack ID. When scanning is complete, position 1 of the rack is in the sampling position.

D. The S/R probe moves to position 1 of the pipetting station, descends to obtain the tip, rises and returns to its Stand-by position.

E. During this time, the reagent disk rotates until the TSH reagent pack is at the cap open/close mechanism. The mechanism moves forward and opens the caps on the reagent pack. The disk rotates again to move the TSH reagent to the R1 position.

F. The S/R probe moves from its Stand-by position to the R1 aspiration position. While activating liquid level detection, the probe descends until it is 2 mm below the reagent surface and aspirates 60 µL of R1.



The lowest allowable point the S/R probe can descend to is 1.3 mm above the bottom of the reagent pack.

1. While aspirating R1, the gripper puts another tip in position 1 of the pipetting station.

G. If the S/R probe does not detect liquid during descent, no reagent aspiration can occur. Alarm 37-01-02 (Assay reagent short) is generated.

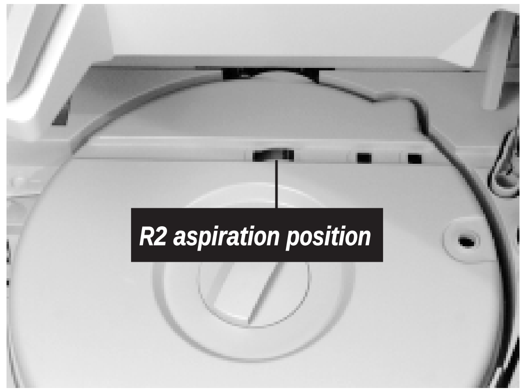
H. After R1 aspiration, the S/R probe rises and moves to the rinse station. To prevent the aspirated R1 from contacting the water in the rinse station, the probe aspirates 10 µL of air. The rinse station externally washes the tip.

I. During step H, the reagent disk rotates until the TSH reagent pack is in the R2 position.

3.2 Detailed Assay Sequence

J. The S/R probe moves from the rinse station to the R2 position while aspirating another 10 µL of air. This air layer prevents R1 from mixing with R2. While activating liquid level detection, the probe descends until it is 2 mm below the reagent surface and aspirates 50 µL of R2.

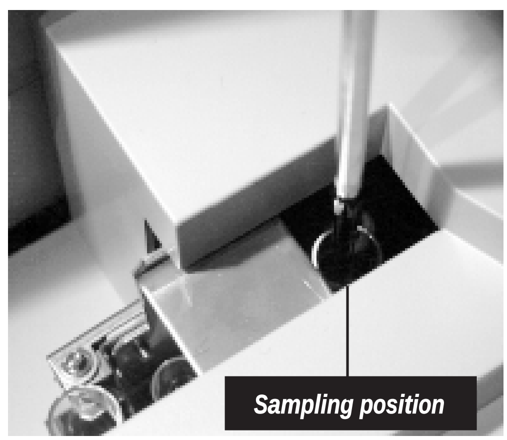
    1. While aspirating R2 the gripper moves an assay cup to position 5 of the pipetting station.



K. Upon completion of R2 aspiration, the S/R probe rises and moves to the rinse station. To prevent the aspirated R2 from contacting the water in the rinse station, the probe aspirates another 10 µL of air. The rinse station externally washes the tip.

L. After R2 aspiration, the reagent disk rotates until the TSH reagent pack is at the cap open/close mechanism. The mechanism moves out and closes the caps.

M. The S/R probe moves from the rinse station to the sampling position while aspirating another 10 µL of air. While activating liquid level detection, the probe descends until it is 2 mm below the sample surface and aspirates 50 µL of sample. During sample aspiration, clot detection is activated.



N. The S/R probe moves from the sampling position to position 5 of the pipetting station. The probe descends until the tip reaches 2 mm below where the calculated level of the reaction mixture surface should be and dispenses the sample, R2 and R1. The probe's downward displacement is determined by calculating the reaction mixture volume for the sample and utilizing downward displacement tables in the software. The probe does not rise during dispense.

O. After dispense, the S/R probe moves to the tip eject position and ejects the tip.

First Incubation

A. The gripper grasps and transports the cup containing the reaction mixture from the pipetting station to the incubator.

B. The cup is incubated at 37 °C for nine minutes.

C. During incubation, the analyzer continues to perform operations for other test(s) or sample(s), if necessary.

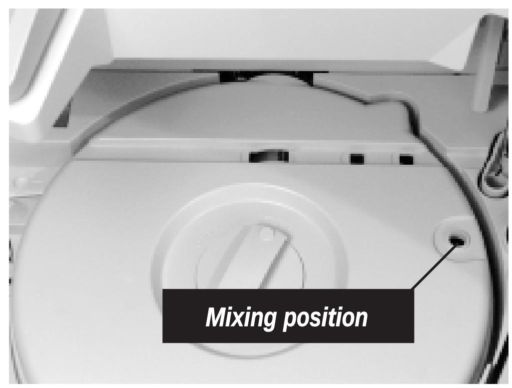
Microparticle Preparation

Before the first incubation is completed, the TSH microparticles are mixed to facilitate microparticle aspiration and dispense.

A. The reagent disk rotates until the TSH reagent pack is at the reagent cap open/close mechanism. The mechanism moves out and opens the caps. The disk moves the reagent pack to the mixing position.

B. The mixer moves over the reagent disk and descends into the microparticles to a level 1.4 mm above the bottom of the bottle.

The mixer descends to this level regardless of the volume of microparticles in the bottle.



C. The mixer stirs the microparticles for 3.7 seconds to obtain a homogeneous suspension.

  1. During the mixing, the gripper obtains a fresh assay tip and transports it to position 2 of the pipetting station.

D. When mixing is complete, the mixer rises and returns to the rinse station where it descends and rotates in the rinse station for washing.

E. At the same time, the reagent disk rotates the TSH reagent pack to the microparticle pipetting position.

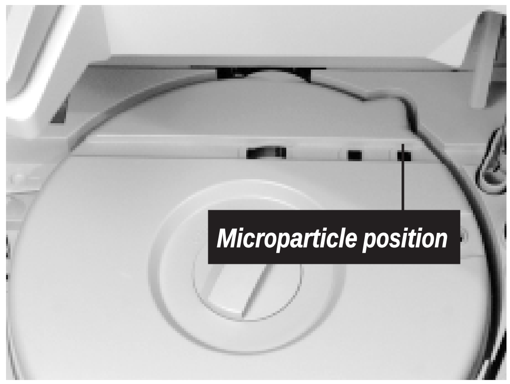
3.2 Detailed Assay Sequence

Microparticle Aspiration and Dispense

A. The gripper grasps the incubating cup and transports it to position 5 of the pipetting station.

B. The S/R probe moves to the pipetting station and obtains the fresh tip and moves to the microparticle pipetting position.

C. While activating the liquid level detection, the S/R probe descends to 2 mm below the reagent surface and aspirates 40 µL of microparticles.



D. After reagent aspiration, the S/R probe rises, moves to position 5 of the pipetting station and descends to dispense the microparticles.

E. After dispense, the S/R probe descends further until it is 0.8 mm above the bottom of the cup and aspirates either the entire volume of reaction mixture or 190 µL of the reaction mixture, whichever volume is smaller. The probe rises while dispensing the reaction mixture back into the cup, thereby mixing the solution and accelerating the reaction in the cup. This mixing takes place only once.

F. The S/R probe moves to the tip eject position and discards the tip.

Second Incubation

A. The gripper grasps the cup containing the mixed reaction mixture and returns it to the incubator.

B. The cup is incubated at 37 °C for 9 minutes.

C. During incubation, the analyzer continues to perform operations for other test(s) or sample(s), if necessary.

Measurement Process Preparations

Before the second incubation is completed, the sipper probe aspirates ProCell into the measuring cell to facilitate measurement.

A. The sipper probe moves from its home position to a ProCell bottle and descends to 2 mm below the solution level and aspirates ProCell into the measuring cell. During descent, liquid level detection is activated.

The sipper probe can descend as low as 1.3 mm above the bottom of the ProCell bottle.

B. The sipper probe rises.

Measurement Process

A. The gripper grasps and transports the cup that has completed its second incubation from the incubator to the aspiration station.

B. The sipper probe moves to the aspiration station and descends into the cup until it is 0.8 mm above the cup bottom. This descent is independent of the reaction mixture volume.

C. When the sipper probe detects the reaction mixture in the cup, it aspirates 150 µL.

D. After aspiration, the sipper probe rises, aspirates 10 µL of air and moves to the sipper rinse station to descend for rinsing.

E. The gripper grasps the cup from the aspiration station, transports it to the cup disposal opening and discards the cup.

F. The sipper probe is rinsed.

G. The sipper probe rises and moves to the ProCell position, descends into the bottle and aspirates ProCell in a set aspiration/dispense sequence. The immune complex is captured by the magnet onto the electrode of the measuring cell. The ProCell washes away all unbound reagent and serum constituents.

H. After the bound-free separation, a voltage is applied between the working electrode and the counter electrode. The ECL reaction is initiated and measured by the photomultiplier.

3.2 Detailed Assay Sequence

I. After measurement, the sipper probe rises and moves to the CleanCell position and aspirates 20 µL of air. The probe then descends into the CleanCell bottle and aspirates reagent. This procedure is repeated eight times. The alternate flow of air and cleaning solution washes the measuring cell. During this washing process, a voltage is applied between the electrodes, which aids in the cleaning process.

J. The sipper probe moves to the sipper rinse station, aspirates 20 µL of air and descends into the rinse station for washing.

K. Finally, the sipper probe rises and moves to the ProCell bottle. The probe descends into the bottle and aspirates 500 µL of ProCell. Next, the probe aspirates 90 µL of ProCell and moves to the rinse station. At the rinse station, the probe dispenses 35 µL to flush the probe and prepare it for the next sample. During the aspirations of the ProCell, a sequence of voltages is applied three times to prepare the electrodes for the next measurement.

One cycle of the measurement process consumes approximately 2 mL each of ProCell and CleanCell.

Signal Detection and Conversion

The measuring cell is kept at a constant 28 °C throughout the measurement process. The photomultiplier tube detects and converts the ECL signal into an electric signal from which the 2010 calculates assay results. For details on this process, refer to Chapter 4, ECL Technology.

Automatic Analyzer Cycles

There are certain analyzer functions that occur automatically while the analyzer is powered ON.

- While in operation, the solid waste tray periodically shakes for 1.5 seconds.
- While in Stand-by, the reagent disk turns 90° every 30 minutes.
- While in Stand-by, the rinse stations for the S/R probe and sipper probe are switched on for 3 seconds every 30 minutes.
- Microparticles undergo a long mix when starting from Stand-by and then every 90 minutes.
- Microparticles undergo a short mix during operation and then every 60 minutes for each reagent pack not being used.

Dilution Steps

The following is a description of how an assay with a dilution is performed, including the number of assay tips and assay cups used in the process.

Assay With One Step Dilution (3 tips and 2 cups)

Tip 1	➲	diluent (wash)* + sample	➲	cup 1
Tip 2	➲	R1 (wash)* + R2 (wash)* + diluted sample from cup 1	➲	cup 2 ... 1st incubation
Tip 3	➲	M (wash)*	➲	cup 2 ... 2nd incubation
Detection				

**(wash) = the outside of the assay tip is washed.*
R1 = Reagent 1
R2 = Reagent 2
M = Microparticles

Assay With Two Step Dilution (4 tips and 3 cups)

Tip 1	➲	diluent (wash)* + sample	➲	cup 1
Tip 2	➲	diluent (wash)* + diluted sample from cup 1	➲	cup 2
Tip 3	➲	R1 (wash)* + R2 (wash)* + diluted sample from cup 2	➲	cup 3 ... 1st incubation
Tip 4	➲	M (wash)*	➲	cup 3 ... 2nd incubation
Detection				

**(wash) = the outside of the assay tip is washed.*
R1 = Reagent 1
R2 = Reagent 2
M = Microparticles

3.3 Dilution Steps

Pretreatment Steps

In certain test protocols, pretreatment reagent is added prior to R1, R2 or M.

Pretreatment Assay (3 tips and 1 cup)

Tip 1	➲	PT1 (wash)* + PT2 (wash)* + sample	➲	cup 1 ... 1st incubation
Tip 2	➲	R1 + pretreated sample in cup 1	➲	cup 1 ... 2nd incubation
Tip 3	➲	M (wash)* + R2 + reaction mixture in cup 1	➲	cup 1 ... 3rd incubation
Detection				

**(wash) = the outside of the assay tip is washed.*
PT1 = Pretreatment 1
PT2 = Pretreatment 2
R1 = Reagent 1
R2 = Reagent 2
M = Microparticles

3.4 Analyzer Status Conditions

Introduction

The 2010 analyzer can occupy a number of status conditions. A table of the status conditions you normally see during routine operation or maintenance procedures is listed below. There are several other conditions that exist; however, most of these status conditions are seen during various adjustment or maintenance procedures performed by a Roche Diagnostics representative. These additional status conditions are not included in the table below.

A. Stop
The analyzer is no longer able to continue operation. An alarm was issued. Take the appropriate measures to resolve the problem. For further details on A. Stop, refer to Chapter 3, Instrument Alarms – *User's Guide*.

A. Stop/L. Stop
The analyzer is already in A. Stop status when the lines stop operation. For further details on A. Stop and L. Stop, refer to Chapter 3, Instrument Alarms – *User's Guide*.

A. Stop/R. Stop
The analyzer is already in A. Stop status when the A-Line stops supplying racks to the B-Line. For further details on A. Stop and R. Stop, refer to Chapter 3, Instrument Alarms – *User's Guide*.

BC card scan
This status is seen when a bar code card scan is initiated from the CONTROL DEFINITION or CALIBRATION DATA screens.

E. Stop
An emergency stop condition exists. An alarm was issued. Take the appropriate measures to resolve the problem. For further details on E. Stop, refer to Chapter 3, Instrument Alarms – *User's Guide*.

FD Access
This status occurs when a disk reading/writing utility is initiated from the MAINTENANCE screen.

FDD cleaning
This status occurs when a floppy disk drive cleaning is initiated from the MAINTENANCE screen.

Finalization
The status of the analyzer when it is between the status conditions S. Stop and Stand-by.

Finalization maint.
This status occurs when Finalization Maintenance is initiated from the MAINTENANCE screen.

3.4 Analyzer Status Conditions

Initialization
This status is seen when the 2010 is powered ON or when Start is pressed from Stand-by.

L. and A. reset all
L. and A. (line and analyzer) reset all status occurs when the corresponding function is initiated from the MAINTENANCE screen. This function resets the analyzer and the lines.

L. Stop
All lines stop operation. An alarm was issued. Take the appropriate measures to resolve the problem. For further details on L. Stop, refer to Chapter 3, Instrument Alarms – *User's Guide*.

Liquid flow cleaning
Liquid flow cleaning occurs when this function is initiated from the MAINTENANCE screen.

M. Cell preparation
M. Cell preparation occurs when this function is initiated from the MAINTENANCE screen.

Operation
This is the status during which the 2010 performs its routine operations.

P. Stop
A partial stop condition exists. An alarm was issued. Take the appropriate measures to resolve the problem. For further details on P. Stop, refer to Chapter 3, Instrument Alarms – *User's Guide*.

R. Stop
This status occurs when there are no more racks to process on the A-Line or B-Line.

Rack clear
Rack clear status occurs when the corresponding function is initiated from the MAINTENANCE screen. This function clears any remaining racks on the A-, B- or C-Lines.

Reagent scan
This status is seen when a reagent scan is initiated from the INVENTORY screen.

S/R pipettor prime
This status occurs when the S/R pipettor prime is initiated from the MAINTENANCE screen.

S/R probe LLD volt.
This status is seen when the analyzer is monitoring the liquid level detection voltage of the S/R probe. The check is initiated from the VOLTAGE MONITOR

screen (UTIL) folder.

S. Stop
This status occurs when Smpl. Stop is pressed or when sampling is complete (disk system).

S. Stop-S. Scan
The analyzer is in S. Stop and a sample scan is requested from the ORDERS screen, or Start is pressed while the analyzer is in S. Stop.

Sample scan
This status occurs when a sample scan is initiated from the STATUS screen.

Sipper LLD volt.
The analyzer is monitoring the liquid level detection voltage of the sipper probe. The check is initiated from the VOLTAGE MONITOR screen (UTIL) folder.

Sipper pipet. prime
This status occurs when the sipper pipettor prime is initiated from the MAINTENANCE screen.

Sleep
The operation switch is OFF and the circuit breaker is ON.

Stand-by
The analyzer is not performing any operations.

Stop
This status occurs when Stop is pressed or when a Stop alarm condition exists. If an alarm exists, take the appropriate measures to resolve the problem. For further details on Stop, refer to Chapter 3, Instrument Alarms – *User's Guide*.

System reset
A system reset is initiated from the MAINTENANCE screen.

Notes

Chapter 4

ECL Technology

4.1 ECL Technology

Introduction

The last years have seen the development and refinement of many new immunoassay measurement principles and systems. The major trend has been away from liquid phase assays with radioisotopic labels, and towards fast solid-phase assays based on monoclonal antibodies. This development is moving further towards precise and reliable non-isotopic, automated or semi-automated laboratory assays with detection limits measured in the picomolar (10^{-12}) and attomolar (10^{-18}) range.

ECL Assay Principles

Electrochemiluminescent (ECL) processes are known to occur with numerous molecules including compounds of ruthenium, osmium, rhenium or other elements.

ECL is a process in which highly reactive species are generated from stable precursors at the surface of an electrode. These highly reactive species react with one another, producing light.

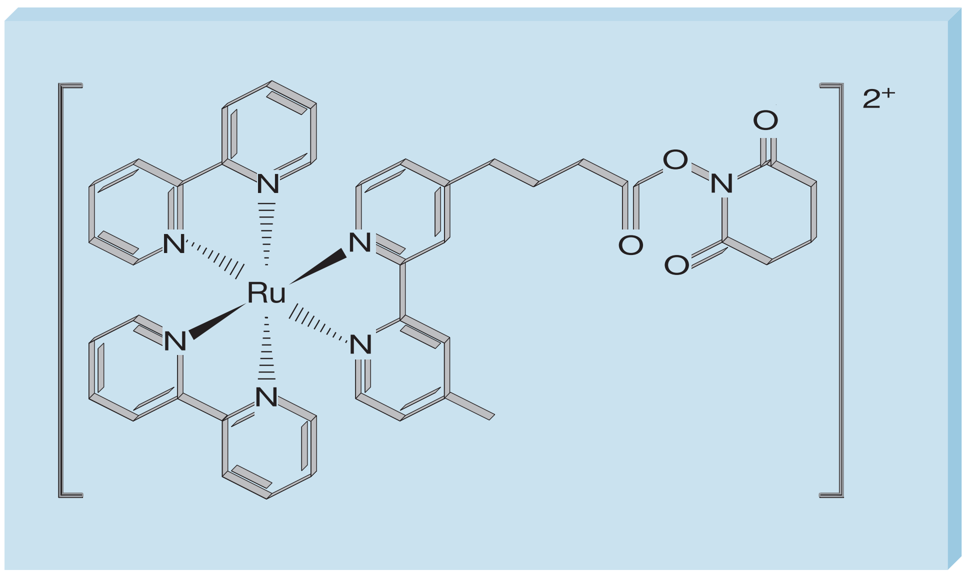
The development of ECL/Origen immunoassays is based on the use of a ruthenium(II)-tris(bipyridyl) [Ru $(bpy)_3^{2+}$] complex and tripropylamine (TPA). The final chemiluminescent product is formed during the detection step.

The chemiluminescent reactions that lead to the emission of light from the ruthenium complex are initiated electrically, rather than chemically. This is achieved by applying a voltage to the immunological complexes (including the ruthenium complex) that are attached to streptavidin-coated microparticles. The advantage of electrically initiating the chemiluminescent reaction is that the entire reaction can be precisely controlled.

Use of the Ruthenium Complex

ECL technology uses a ruthenium chelate as the complex for the development of light. Salts of ruthenium-tris(bipyridyl) are stable, water-soluble compounds. The bipyridyl ligands can be readily modified with reactive groups to form activated chemiluminescent compounds.

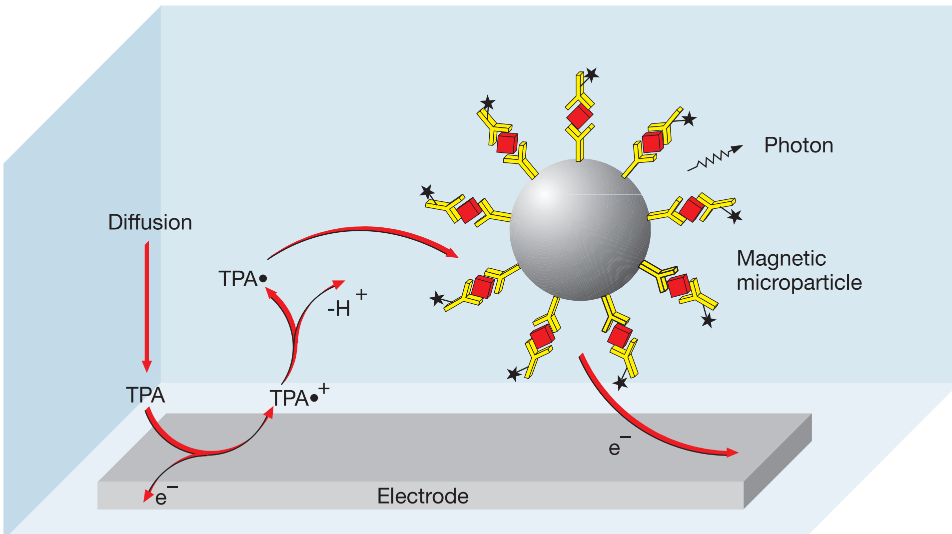
For the development of ECL immunoassays, [$Ru(bpy)_3^{2+}$] N-hydroxysuccinimide (NHS) ester is used because it can be easily coupled with amino groups of proteins, haptens and nucleic acids. This allows the detection technology to be applied to a wide variety of analytes.



The ruthenium complex

4.1 ECL Technology

The ECL Reaction at the Electrode Surface

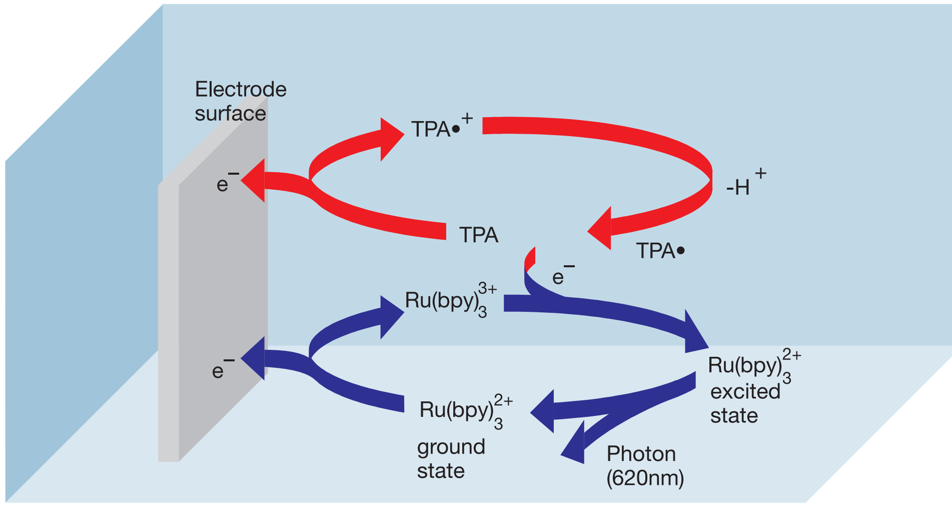


Detection of a ruthenium-labeled immune complex

Two electrochemically active substances, the ruthenium complex and tripropylamine (TPA), are involved in the reactions that lead to the emission of light. Both substances remain stable, as long as a voltage is not applied.

The ECL reaction of ruthenium tris(bipyridyl)$^{2+}$ and tripropylamine occurs at the surface of a platinum electrode. The applied voltage creates an electrical field, which causes all the materials in this field to react. Tripropylamine is oxidized at the electrode, releases an electron and forms an intermediate tripropylamine radical-cation, which further reacts by releasing a proton (H^+) to form a TPA radical (TPA•).

In turn, the ruthenium complex also releases an electron at the surface of the electrode thus oxidizing to form the $Ru(bpy)_3^{3+}$ cation. This ruthenium cation is the second reaction component for the following chemiluminescent reaction with the TPA radical.



The ECL reaction at the electrode surface

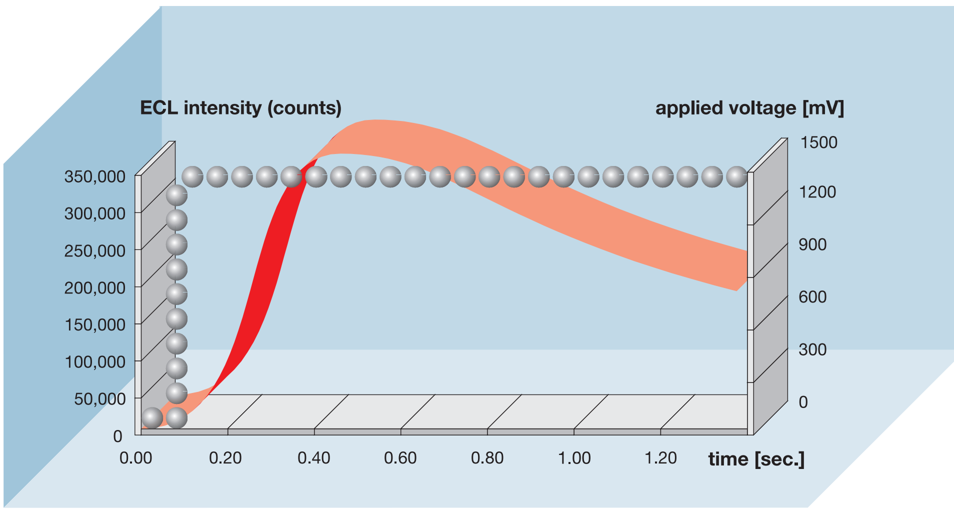
TPA• and $Ru(bpy)_3^{3+}$ react with one another, whereby $Ru(bpy)_3^{3+}$ is reduced to $Ru(bpy)_3^{2+}$ and at the same time forms an excited state via energy transfer. This excited state is unstable and decays with emission of a photon at 620 nm to its original state. The reaction cycle can now start again. The tripropylamine radical reduces to by-products which do not affect the chemiluminescent process. TPA is used up and therefore must be present in excess. The reaction is controlled by diffusion of the TPA and the amount of ruthenium complex present. As TPA in the electrical field is depleted, the signal strength (light) is slowly reduced once the maximum is reached.

Although during measurement, TPA is used up, the ruthenium ground state complex is continually regenerated. This means that the ruthenium complex can perform many light-generating cycles during the measurement process, therefore showing an inherent amplification effect which contributes to the technology's sensitivity. Many photons can be created from one antigen-antibody complex.

4.1 ECL Technology

ECL Signal Generation

The graph displays a typical ECL signal generation. Viewed from an electrical perspective, the reaction can be explained as follows: When a voltage is applied to the detection cell electrode, a peak of light emission occurs over a short time interval and can be detected as the resulting ECL signal. A defined area under the curve is measured around the intensity maximum.



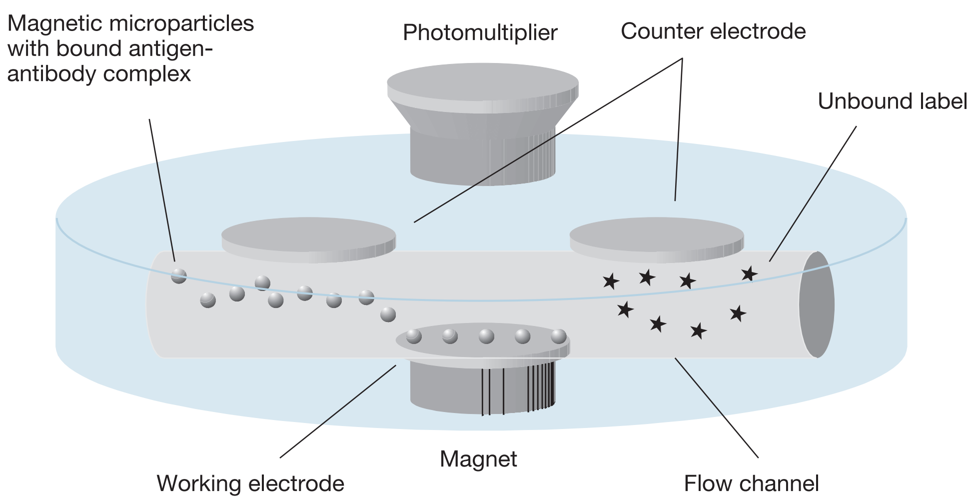
ECL signal generation

The dotted line indicates the voltage at the electrode used to generate the ECL signal. The solid line is the actual light output measured by the photomultiplier detector.

ECL Measuring Cell

The core of the system is the ECL detection cell, which is designed as a flow-through cell. Essentially, three operating steps are performed in the measuring cell:

- **Bound/Free Separation**
  Using a magnet, the streptavidin microparticles that are coated with antigen-antibody complexes, are uniformly deposited on the working electrode. A system buffer (ProCell) is used to wash the particles on the working electrode and to flush out the excess reagent and sample materials from the measuring cell.
- **ECL Reaction**
  The magnet is removed and a voltage is then applied to the electrode on which the microparticles, coated with antigen-antibody complexes, are deposited to initiate the ECL reaction. The light emission is measured with a photomultiplier. The system then uses the corresponding signals for the calculation of results.
- **Release of Microparticles and Cell Cleaning**
  Once the measurement is completed, the paramagnetic microparticles are washed away from the electrode surface with a special cleaning solution (CleanCell). The surface of the measuring cell is regenerated by varying the potential on the electrode. The cell is then ready for another measurement.



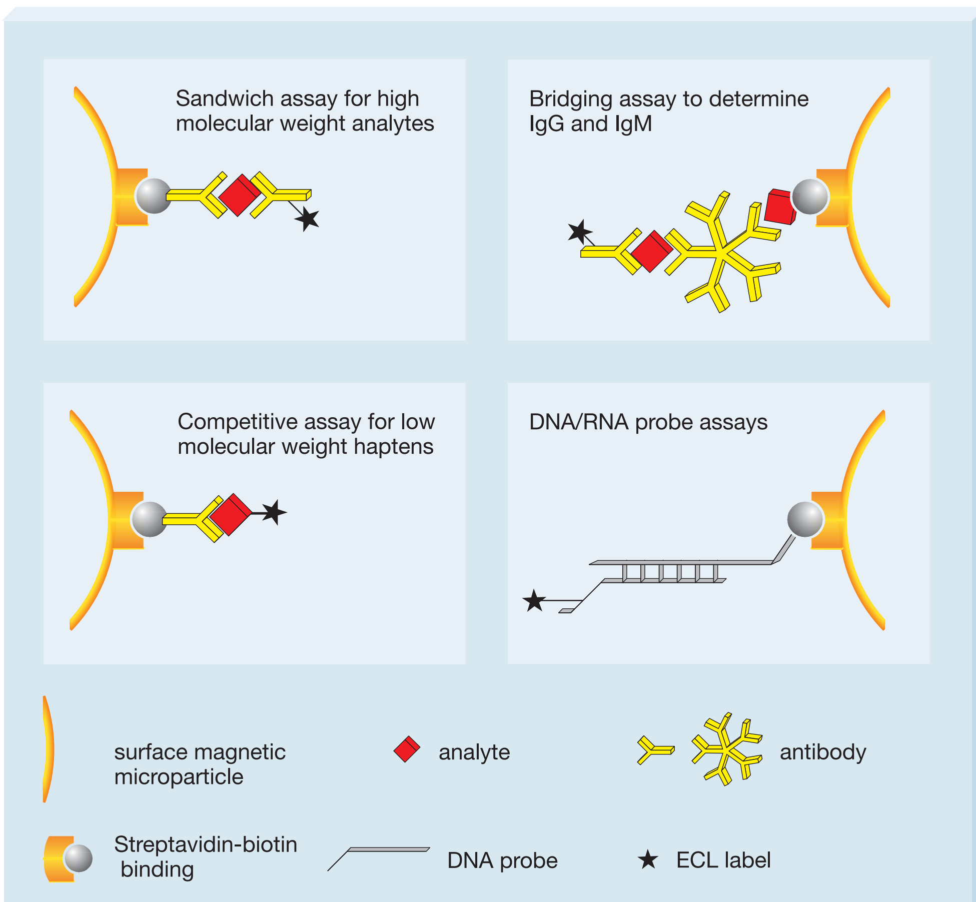
ECL measuring cell

4.1 ECL Technology

Advantages of ECL Technology

Electrochemiluminescence is a highly innovative technology that offers distinct advantages over other detection techniques.

- Extremely stable non-isotopic label allows liquid reagent convenience.
- Enhanced sensitivity in combination with short incubation times means high quality assays and fast result turnaround.
- Large measuring range of five orders of magnitude minimizes dilutions and repeats, reducing handling time and reagent costs.
- Applicable for the detection of all analytes providing a solid platform for menu expansion.



ECL assay types

Chapter 5

Test Principles

5.1 Competitive Test Principle

Introduction

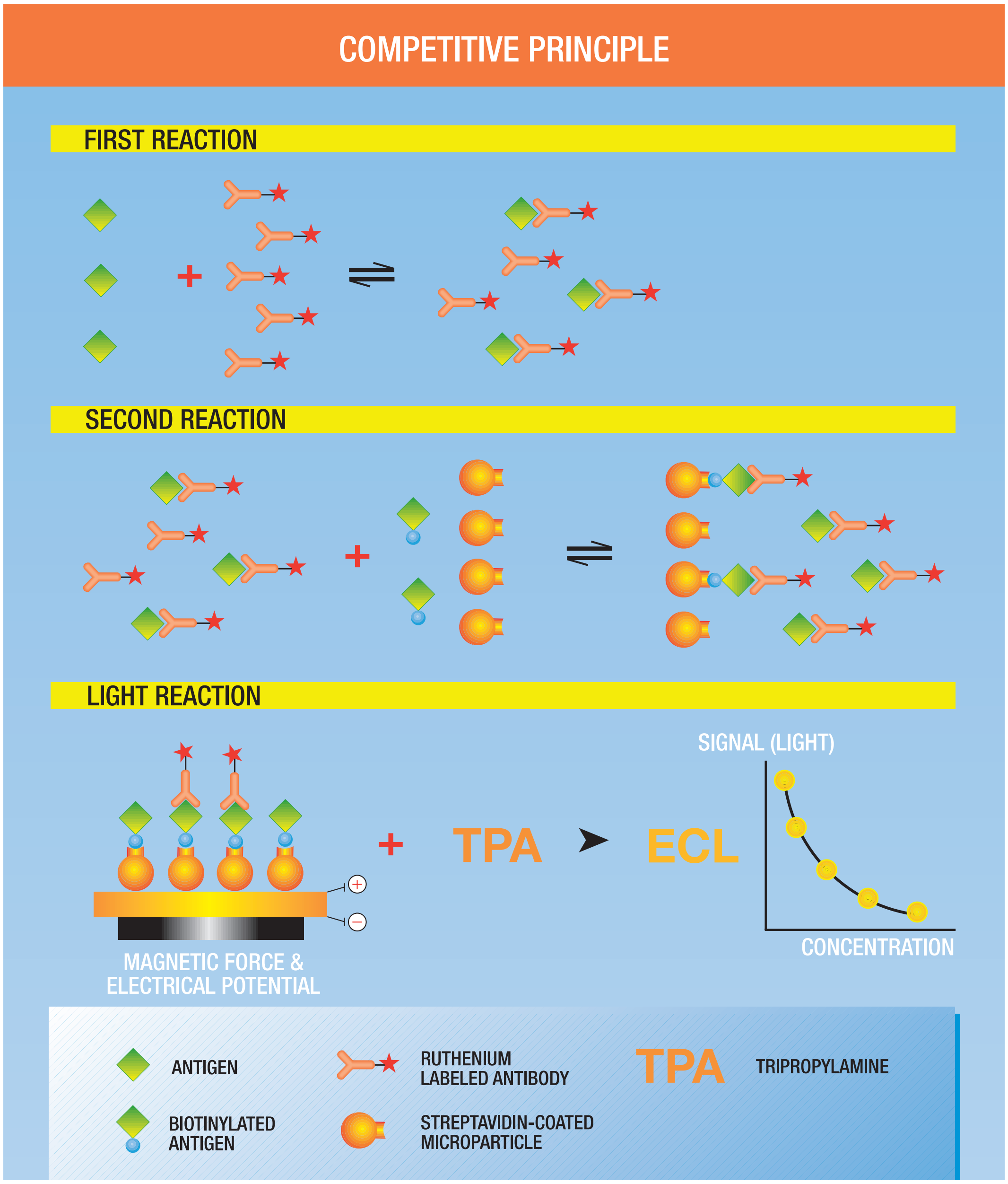
Three test principles are available on the Elecsys 2010 Immunoassay System: Competitive principle for extremely small analytes, sandwich principle (one or two steps) for larger analytes and a bridging principle to detect antibodies in the sample. A fourth method, for the detection of DNA/RNA molecules, is currently under development.

Competitive Principle

This principle is applied to analytes of low molecular weight, such as FT3.

- In the first step, sample and a specific anti-T3 antibody labeled with a ruthenium complex are combined in an assay cup.
- After addition of biotinylated T3 and streptavidin-coated paramagnetic microparticles, the still free binding sites of the labeled antibody become occupied, with formation of an antibody-hapten complex. The entire complex is bound to the microparticle via interaction of biotin and streptavidin.
- After the second incubation, the reaction mixture containing the immune complexes is transported into the measuring cell. The immune complexes are magnetically entrapped on the working electrode, but unbound reagent and sample are washed away by ProCell.
- In the ECL reaction, the conjugate is a ruthenium based derivative and the chemiluminescent reaction is electrically stimulated to produce light. The amount of light produced is indirectly proportional to the amount of antigen in the patient sample.

Evaluation and calculation of concentration of the antigen are carried out by means of a calibration curve that was established using standards of known antigen concentration.



Competitive principle

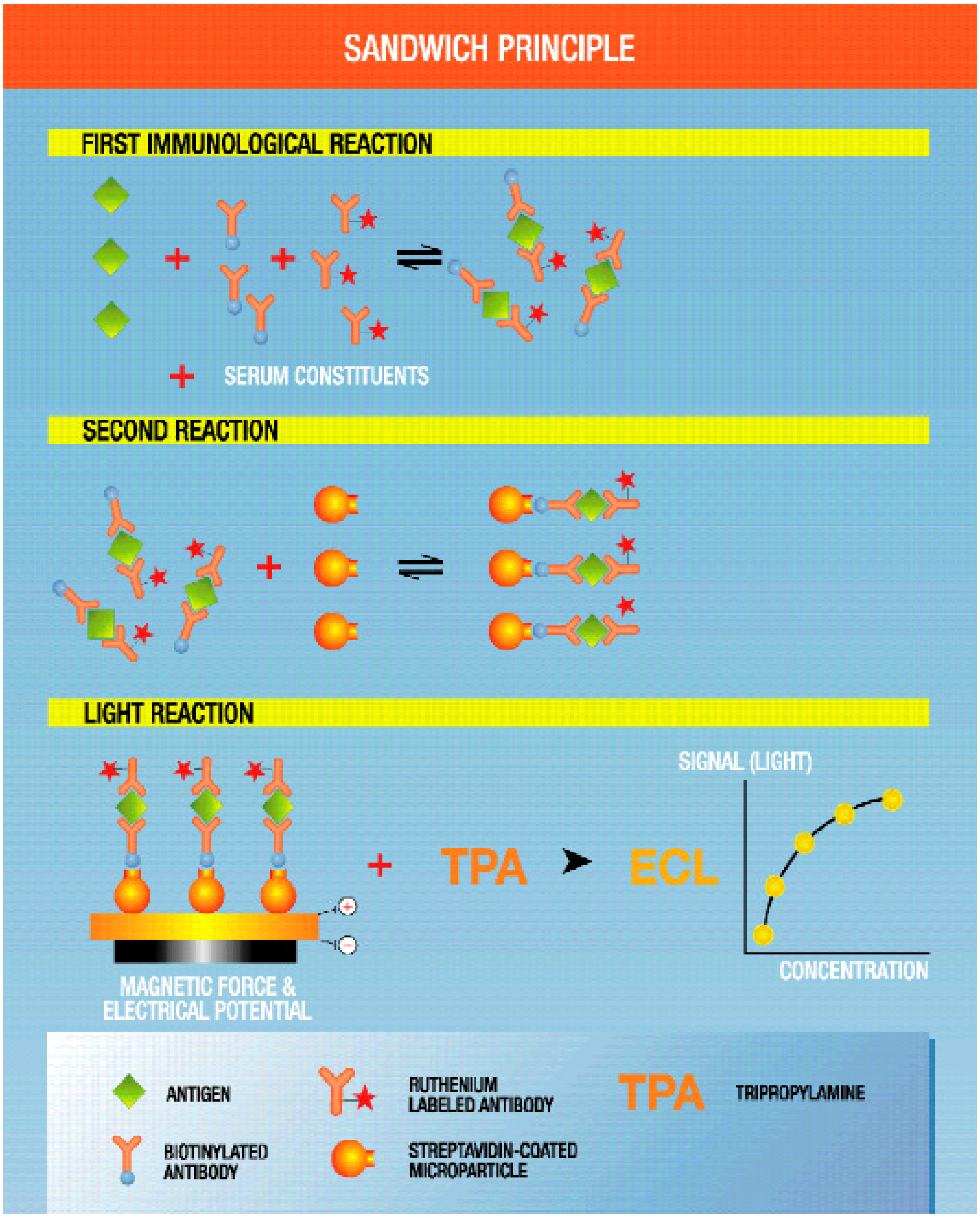
5.2 Sandwich Test Principle

Sandwich Principle

The sandwich principle is applied to higher molecular weight analytes, such as thyroid-stimulating hormone (TSH).

- In the first step, patient sample is combined with a reagent containing biotinylated TSH antibody and a ruthenium-labeled TSH-specific antibody in an assay cup. During a nine-minute incubation step, antibodies capture the TSH present in the sample.
- In the second step, streptavidin-coated paramagnetic microparticles are added. During a second nine-minute incubation, the biotinylated antibody attaches to the streptavidin-coated surface of the microparticles.
- After the second incubation, the reaction mixture containing the immune complexes is transported into the measuring cell; the immune complexes are magnetically entrapped on the working electrode, but unbound reagent and sample are washed away by ProCell.
- In the ECL reaction, the conjugate is a ruthenium based derivative and the chemiluminescent reaction is electrically stimulated to produce light. The amount of light produced is directly proportional to the amount of TSH in the sample.

Evaluation and calculation of concentration of the antigen or analyte are carried out by means of a calibration curve that was established using standards of known antigen concentration.



Sandwich principle

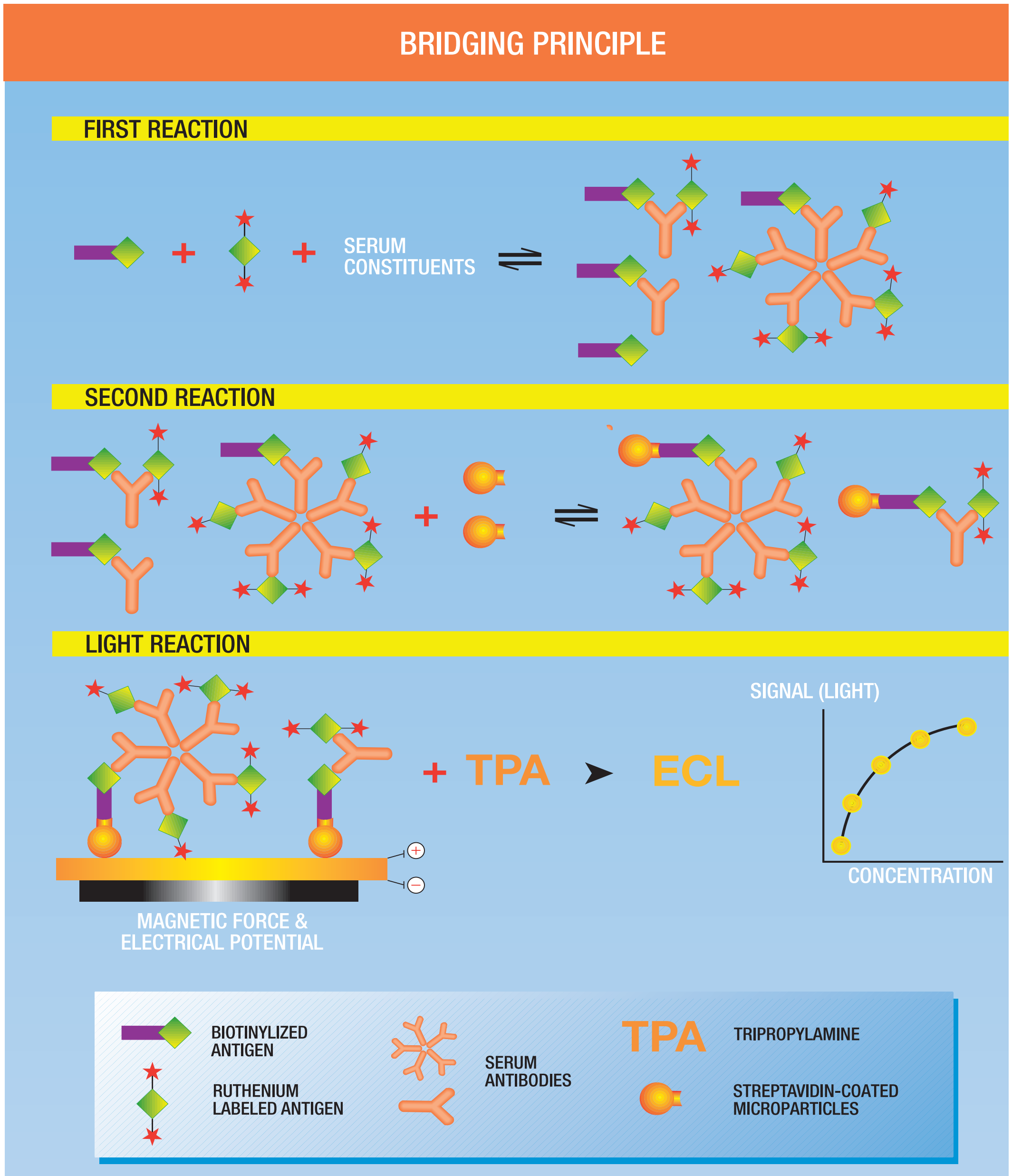
5.3 Bridging Test Principle

Bridging Principle

The bridging principle is similar to the sandwich principle, except that the assay is designed to detect antibodies, not antigens, (e.g., IgG, IgM and IgA). This is accomplished by including biotinylated and ruthenium-labeled antigens in the reagents for which the targeted antibody has affinity.

- In the first step, serum antibodies bind with the biotinylated and ruthenium-labeled antigens to form an immune complex.
- The immune complex then reacts with streptavidin-coated microparticles via the biotinylated antigen.
- After the second incubation, the reaction mixture containing the immune complexes is transported into the measuring cell; the immune complexes are magnetically entrapped on the working electrode, but unbound reagent and sample are washed away by ProCell.
- In the ECL reaction, the conjugate is a ruthenium based derivative and the chemiluminescent reaction is electrically stimulated to produce light. The amount of light produced is directly proportional to the amount of analyte in the sample.

Evaluation and calculation of the concentration of the antibody are carried out by means of a calibration curve that was established using standards of known antibody concentrations.



Bridging principle

Notes

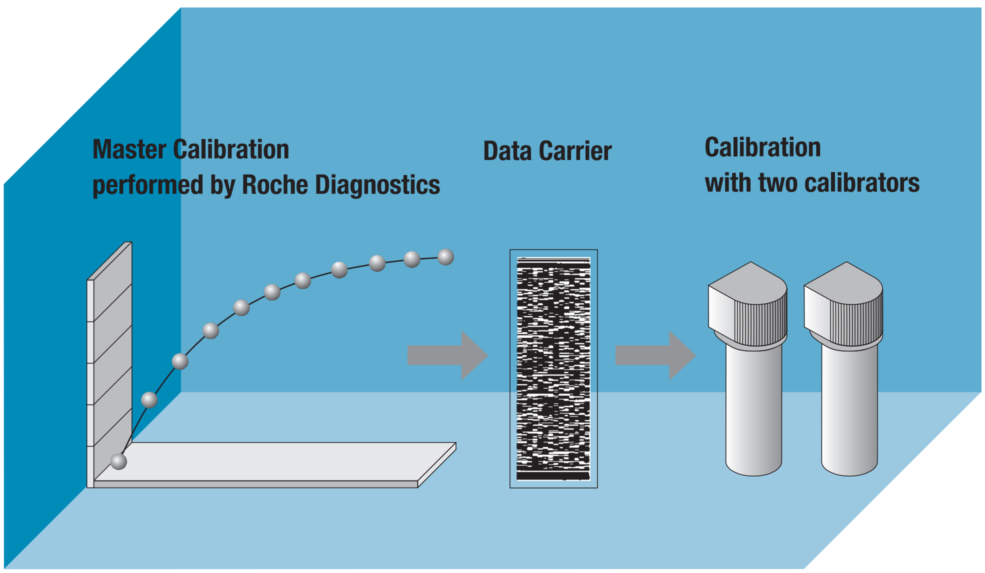
Chapter 6

Calibration

6.1 Reagent Calibration

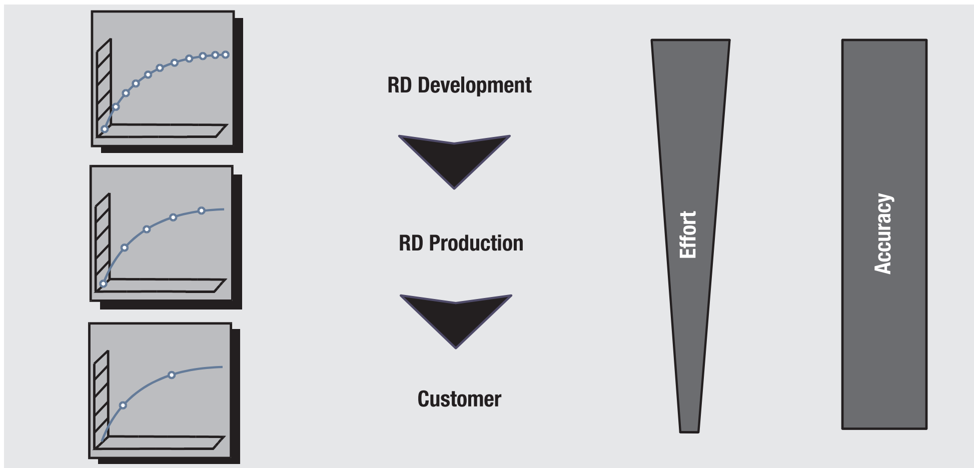
Introduction

Calibration is required to determine the concentration of an unknown substance as accurately as possible independent of reagent lot, reagent conditions, and analyzer conditions. For this, a master calibration curve is generated at Roche Diagnostics during production of the reagent that is encoded in the 2D bar code of the appropriate reagent pack. This information is then transferred to the analyzer. At the customer site, the analyzer generates an update of the master curve by measuring two calibrators under routine laboratory conditions.



The calibration curve produced from the bar-coded master calibration and the measured calibration is specific to each reagent lot and in some cases, to an individual reagent pack. The result of a calibration is validated automatically by the analyzer and can be further validated by the operator.

Master Calibration



Calibration concept of the Elecsys 2010

A reference standardization curve utilizing master test kit reagents and certified reference standard material [e.g., World Health Organization (WHO) reference material] is measured at Roche Diagnostics. This curve uses 10 to 12 points. The reference standard curve is the basis for the production of master calibrators.

A lot-specific master calibration curve (n=5 or 6) is measured at Roche Diagnostics using lot-specific test kit reagents and master calibrators. The shape of the lot-specific master curve is characterized by a four-parameter Rodbard function. The data characterizing this curve is stored in the lot-specific reagent bar code. Lot-specific calibrator assigned values (i.e., CalSet assigned values) are read off the lot-specific master calibration curve and are encoded in the CalSet calibrator bar code card.

At the customer site, the calibration results from two calibrators that were measured under routine conditions are mathematically combined with the encoded data from the 2D bar code. From this combination, the Elecsys 2010 determines a lot calibration or reagent pack calibration from which the concentration of measured samples is reliably calculated.

6.1 Reagent Calibration

Lot Calibration

A lot calibration (L-Cal) is a calibration performed with a fresh reagent pack that has not been on the analyzer longer than 24 hours. Reagent-specific calibrators are used to update two of the four Rodbard curve-defining parameters. This adjusts the curve to match the original lot-specific calibration curve. The lot calibration is valid for all other reagent packs of the same lot, provided these reagent packs were stored as specified in the package insert and not on the analyzer longer than 7 days.

Reagent Pack Calibration

A reagent pack calibration (R-Cal) is performed with a reagent that has been on the analyzer more than 24 hours or is generated by an operator-released calibration. A reagent pack calibration is valid for one specific reagent pack only. The reagent pack calibration is compared to the most recent stored L-Cal for validation.

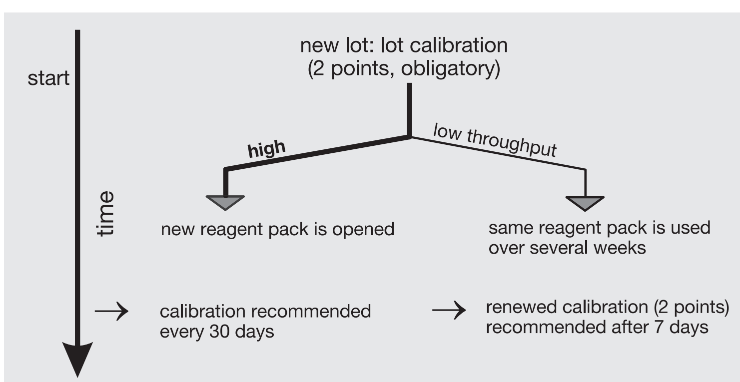
Calibration Stability

The stability of calibration is determined by two factors:

- the long term stability of the instrumentation
- the age of the reagent.

For many assays, a reagent pack will be used within seven days. In this situation, it is not necessary to renew the calibration for the new reagent pack. In this case, the lot calibration can be used for all other new reagent packs for a period as recommended in the package insert (refer to the *Calibration Frequency* section). After that period, a new lot calibration is recommended.

If the reagent is kept on the analyzer for more than seven days, it is recommended to renew the calibration. This renewal of the calibration can be repeated as needed until the on-analyzer open stability of the reagent is exceeded (e.g., two months).



Calibration workflow on the Elecsys 2010

Calibration Validation

The calibration status of the test is easily identified on the CALIBRATION DATA screen by the color of the test button. Three colors are used to distinguish calibration status. They are as follows:

Green: Calibration was successful.

Yellow: Calibration was questionable. You must check the Calibration Data report or view the 'Calibration Data Details' pop-up window to determine which quality criteria were violated. You can release this calibration by touching the test button, followed by the Release button, then OK. If a previous calibration exists, all sample and QC results obtained prior to pressing Release were calculated using the last valid calibration. Review any QC with "Previous Calibration Used" data alarms to determine if patient samples performed at the same time as the yellow calibration may be acceptable.

After releasing the calibration, all subsequent results are calculated using the released calibration. The released calibration is an R-Cal (reagent pack calibration). Repeat QC values to determine the validity of the released calibration.

If the calibration is discarded by touching Reject, then OK, the last valid calibration is used to calculate subsequent sample results.

Red: Calibration failed. The last valid calibration is used to calculate the sample results until the next calibration is performed.

Preceding calibrations can only be used if a valid calibration exists in the software. In the case of rejected questionable calibrations or failed calibrations, perform a new calibration.

Follow your laboratory protocol regarding questionable or failed calibration results.

6.1 Reagent Calibration

Calibration Quality Criteria

Each calibration is automatically validated by the instrument software according to the following criteria. The following is a table of the quality criteria and their affect on the calibration status on a **quantitative** assay.

Color	Calibration Status	Criteria
green	successful ***R-Cal ONLY***	• no values are missing • all values are above the recommended minimum signal level • there are no duplicate errors • calibration factor* is within acceptable range (0.8 - 1.2)
yellow	questionable ***R-Cal ONLY***	• one of either calibrator's duplicate values is missing • one of either calibrator's duplicate values is below the recommended minimum signal level • one calibrator level was measured with a duplicate error (i.e., the signal difference between the two calibrator determinations is too high) • the calibration factor is: 0.6 - 0.79 *OR* 1.21 - 1.4
red	failed ***R-Cal ONLY***	• two or more of the calibrator's replicate values are missing • two or more of the calibrator's replicate values are below the recommended minimum signal level • two calibrator levels were measured with a duplicate error (i.e., the signal difference between the two calibrator determinations is too high) • failure of monotony (e.g., measured calibrator values were not in either ascending or descending order) • calibration factor is out of range (Cal factor < 0.6 *OR* Cal factor > 1.4)

* Each lot calibration (L-Cal) utilizes a calibration factor of 1. For all subsequent reagent pack calibrations (R-Cal), a new calibration factor is calculated. The calibration factor is the quotient of the slope of the actual performed calibration and the related stored calibration.

The following is a table of the quality criteria and their affect on the calibration status on a **qualitative** assay.

Color	Calibration Status	Criteria
green	successful	• no values are missing • the slope is within the bar-coded parameters • all values are greater than the minimum signal and less than the maximum signal • the difference between the negative calibrator and positive calibrator's signal values is greater than the allowable value • there are no duplicate errors • there are no system errors
yellow	questionable	• one of either calibrator's duplicate values is missing • one of either calibrator's duplicate values is out of the allowable minimum/maximum signal range (i.e., one value is less than the minimum signal or greater than the maximum signal) • one calibrator level was measured with a duplicate error (i.e., the signal difference between the two calibrator determinations is too high)
red	failed	• two or more of the calibrator's replicate values are missing • the slope is not within the bar-coded parameters • two or more of the calibrator's replicate values are out of the allowable minimum/maximum signal range (i.e., two or more values are less than the minimum signal or greater than the maximum signal) • the difference between the negative calibrator and positive calibrator's signal values is less than or equal to the allowable value • two calibrator levels were measured with a duplicate error (i.e., the signal difference between the two calibrator determinations is too high)

6.2 Calibration of Quantitative Assays

Introduction

The following is a description of the different methods utilized by the Elecsys 2010 analyzer for calculating results. To calculate quantitative tests, the 2010 utilizes the following three calibration functions to convert measured signals into concentrations:

- Rodbard function
- linear calibration function
- linear-reciprocal calibration function.

The calibration function used by the system is encoded in the 2-dimensional bar code on the appropriate reagent pack. The calculations are performed automatically by the analyzer, including the correction for samples diluted by the analyzer.

Rodbard Function

The conversion of the measured signal into a concentration using the Rodbard function is as follows:

$$y = \frac{a - d}{1 + \left(\frac{x}{b}\right)^{c}} + d$$

x	=	Sample concentration
a, b, c, d	=	Rodbard function parameters
y	=	Signal

Parameters **b** and **c** define the shape of the curve and parameters **a** and **d** define the position of the curve.

Under the controlled conditions of automation on the analyzer, the shape of the calibration curve is very stable and, therefore, it is possible to calibrate this nonlinear function with only two calibrators and the information of the shape parameters **b** and **c**. The curve position parameters **a** and **d** are calculated with each calibration. Such a calibration is called 2-point calibration.

The following inverse formula is used to determine the unknown's concentration based on its signal.

$$x = b \left(\frac{a - y}{y - d}\right)^{1/c}$$

y	=	Signal
a, b, c, d	=	Rodbard function parameters
x	=	Sample concentration

Linear Calibration Function

The conversion of the measured signal into a concentration is as follows:

$$y = b \quad x + a$$

y	=	Signal
x	=	Concentration
a, b	=	Calibration curve parameters (y-intercept and slope)

Calibrations using a linear calibration curve are always performed using two calibrators.

The following inverse formula is used to determine the unknown's concentration based on its signal.

$$x = \frac{y - a}{b}$$

x	=	Sample concentration
a, b	=	Calibration curve parameters
y	=	Signal

Linear Reciprocal Calibration Function

The conversion of the measured signal into a concentration is as follows:

$$\frac{1}{y} = b \quad x + a$$

y	=	Signal
x	=	Concentration
a, b	=	Calibration curve parameters (y-intercept and slope)

Calibrations using a linear reciprocal calibration curve are always performed using two calibrators.

The following inverse formula is used to determine the unknown's concentration based on its signal.

$$x = \frac{1 - ay}{by}$$

x	=	Sample concentration
a, b	=	Calibration curve parameters
y	=	Signal

6.3 Calibration of Qualitative Assays

Calibration of Qualitative Assays

For qualitative tests (cut-off tests), a cut-off value is established. Using this cut-off, patient samples can be assessed as reactive, non-reactive or borderline.

For calibration, two calibrators [reactive (REAC) and non-reactive (N-REAC)] are used. The calibrators produce effective signals from which the cut-off value can be calculated as follows:

$$S_{Cut\text{-}off} = (A \; S_{NEG}) + (B \; S_{POS}) + C$$

$S_{Cut\text{-}off}$	=	Cut-off
S_{POS}	=	Effective signal of the reactive calibrator
S_{NEG}	=	Effective signal of the non-reactive calibrator
A, B, C	=	Assay specific cut-off parameters (according to the 2D bar code)

A cut-off index is calculated from both calibrators.

$$\text{Cut-Off}_{IndexNEG} = \frac{S_{NEG}}{S_{Cut\text{-}off}}$$

$$\text{Cut-Off}_{IndexPOS} = \frac{S_{POS}}{S_{Cut\text{-}off}}$$

$\text{Cut-off}_{IndexNEG}$	=	Cut-off index of the non-reactive calibrator
$\text{Cut-off}_{IndexPOS}$	=	Cut-off index of the reactive calibrator
S_{NEG}	=	Effective signal of the non-reactive calibrator
S_{POS}	=	Effective signal of the reactive calibrator
$S_{Cut\text{-}off}$	=	Cut-off of the calibrator

Both the REAC and N-REAC cut-off indices are used to check the quality of the calibration.

The calibration status is made up of the following parameters:

- Cut-off $S_{Cut\text{-}off}$
- Cut-off indices of both REAC and N-REAC calibrators.

Calibrations for qualitative tests are always performed using both reactive and non-reactive calibrators.

Result Calculation for Qualitative Assays

To calculate the qualitative test (cut-off tests) result the 2010 compares the effective signal with a cut-off signal that was measured during calibration. Defined limit values are contained in the 2D bar code.

The cut-off index required to evaluate the test result compares the behavior of the sample signal to the cut-off signal.

$$\text{Cut-Off}_{\text{Index}} = \frac{S_{\text{eff}}}{S_{\text{Cut-off}}}$$

$\text{Cut-Off}_{\text{Index}}$ = Cut-off index

S_{eff} = Effective signal of the sample measurement

S_{CutOff} = Cut-off signal of the calibration

Sandwich tests exhibit a positive slope, for competitive tests the slope is negative. Result output is as follows:

reactive: if the result for a positive curve slope is greater than or equal to the upper limit of the defined cut-off index;

or, if the result for a negative curve slope is less than or equal to the lower limit of the defined cut-off index.

non-reactive: if the result for a positive curve slope is less than the lower limit of the defined cut-off index;

or, if the result for a negative curve slope is greater than the upper limit of the defined cut-off index.

borderline: if the result for a positive curve slope is greater than or equal to the lower limit and less than the upper limit of the defined cut-off index;

or, if the result for a negative curve slope is less than the upper limit and greater than the lower limit of the defined cut-off index.

Cut-Off Index	Slope	Result	Flag/Output
x < LL	+	non-reactive	n-reac.
LL - x < UL	+	borderline	border
UL - x	+	reactive	reac.
x - LL	-	reactive	reac.
LL < x - UL	-	borderline	border
UL < x	-	non-reactive	n-reac.

x = Cut-Off Index
LL = Lower limit of the Cut-Off Index
UL = Upper limit of the Cut-Off Index

Notes

Glossary

Glossary

Numbers

2-dimensional bar code
: (2D) type of bar code found on the reagent pack, calibrator and control bar code cards. Utilizes PDF417 symbology. This bar code contains more information than traditional linear bar codes.

A

A-Line
: the unit of the rack sampler where you load the tray and sample racks.

adequate sample volume
: the amount of sample remaining in the sample container after all assays have been pipetted is greater than or equal to the recommended dead volume for the container.

analytical sensitivity
: the lower detection limit (LDL) of the assay. The analytical sensitivity represents the lowest analyte concentration that can be distinguished from zero. It is calculated as the concentration two standard deviations above the lowest standard used in the master calibration. Since the master calibration is performed by Roche Diagnostics, it is not possible for the customer to verify the sensitivity exactly as it was performed at Roche Diagnostics. CalSet vial 1 was not used to determine analytical sensitivity. Master calibration standards were used.

analyzer unit
: the analyzer unit consists of the sample/reagent area, consumables area, measuring area and power switch.

aspiration station
: position located next to the incubator where the assay cup containing reaction mixture is placed for aspiration into the measuring cell by the sipper probe.

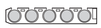
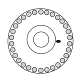
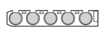
assay
: - a specific test.
  - the process of measuring a substance.

assay cup (or cup)
: clear plastic cup that is used to hold the assay reaction mixture. Cups are configured in trays that contain 60 cups each.

assay tip (or tip)
: disposable pipette tip made of black, conductive plastic. Assay tips are used by the sample/reagent (S/R) probe. Tips are configured in trays that contain 120 tips each.

assigned values
: the assigned value for a calibrator (Cal 1 or Cal 2) is encoded on the calibrator bar code card.

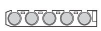
B

B-Line 	transports sample racks, single file, first to the rack bar code reader and then to the sampling position.
bar code	a series of lines representing data encoded in a format containing information that can be automatically scanned. Bar codes used on the analyzer can either be linear or 2D.
bar code card	either a calibrator or control card. These cards contain either all assigned values (calibrator card) or target values and ranges (control card) for assays.
bar code card reading station 	slot located between the sample disk and the reagent disk where the calibrator or control bar code cards are scanned.
bar code card reading station 	slot located to the back left of the reagent disk where the calibrator or control bar code cards are scanned.
bar code reader	the device that reads the code from a sample, reagent bar code label or bar code card.
bar code scan	process to read the bar code information into instrument memory. Three are possible: reagent scan, sample scan (disk system only) and bar code card scan.
BC card scan	a scan to read the information from the 2D calibrator bar code card or control bar code card.
BlankCell	reagent pack used to perform an initial BlankCell procedure. This procedure is primarily done by RD Service.
block	a result can be blocked by the operator (B) or the system (S). A blocked result is printed or uploaded to the host with the appropriate flag (i.e., “B” or “S”). Block a result that is questionable and that should be repeated.
bottle set 1	the set of ProCell/CleanCell that occupies positions 1 and 2 in the system reagent compartment.
bottle set 2	the set of ProCell/CleanCell that occupies positions 3 and 4 in the system reagent compartment. When starting from Stand-by, the analyzer always accesses bottle set 2 first.
bound/free separation	the physical separation of reagent and/or sample which is bound to a solid phase (i.e., microparticles) from free reagent and/or sample. This step occurs in the measuring cell.

bridging principle — one of three test principles available on the 2010 analyzer. It is used to detect antibodies in the sample (e.g., IgG, IgM or IgA).

button — buttons are found on the screen or pop-up window. They can be touched to either initiate an action or move to a different screen. Buttons found on a screen are “screen buttons” and buttons found on a pop-up window are “window buttons.”

C

C-Line  — receives racks from the B-Line. It holds a maximum of 15 racks at a time.

calibration — the process to standardize the instrument with samples of known concentration. This process establishes factors and or updates baselines to enable conversion of the response of the instrument to concentration (or activity) for the constituent being measured.

calibration factor — one of the six calibration quality criteria used to determine the outcome of a calibration. This criterion is only used in determining R-Cals. It is derived by the comparison of two different calibrations. A factor of 1.0 is produced if the two calibration are perfectly matched. Each R-Cal is compared to the L-Cal to generate this factor. A successful calibration should have a factor of 0.8 - 1.2. The remaining criteria are missing values, monotony of curve, minimum signal, deviation of duplicate measurements and system errors.

calibration frequency — the specified interval at which an assay must be calibrated. This frequency is found in reagent package inserts.

calibration function — the type of calibration (e.g., Rodbard function, linear function, cutoff function).

calibration quality criteria — criteria applied to the automatic validation of every calibration on the analyzer.

calibration type — lot calibration (L-Cal) or reagent pack calibration (R-Cal)

calibration validation — procedure performed by the analyzer software whereby a calibration data set is checked versus specific criteria encoded in the reagent bar code. The conclusion of a validation is a green (successful), yellow (questionable) or red (failed) calibration.

calibration verification
a procedure required by HCFA and CLIA. "Calibration verification is the assaying of calibration materials in the same manner as patient samples to confirm that the calibration of the instrument kit or test system has remained stable throughout the laboratory's reportable range for patient test results."[1]

calibrator
a substance with known concentrations used in the calibration of immunoassays.

capacitance
used in liquid level detection in the S/R probe and sipper probes. The probes carry a high frequency low voltage electrical charge. The frequency and electrical charge characteristics are altered and sensed when the probe touches liquid.

CapTwist
opener to aid in the manual removal of ProCell and CleanCell bottle caps.

circuit breaker
found on the lower right side of the analyzer. It controls power to the peltiers, thereby controlling the temperature in the reagent disk, incubator, system reagent compartment and measuring cell.

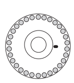
CleanCell
reagent used to:

- cleanse the tubing system and measuring cell after each measurement
- condition the electrodes.

Clean-Liner
disposable liner used in the solid waste tray. Clean-Liner has a sliding lid that can be closed to prevent spillage of potentially biohazardous material from used tips and cups.

clot detection
used in the aspiration systems of the S/R probe. As the appropriate volume of sample is aspirated, the release of vacuum is monitored by a vacuum/pressure transducer. If an abnormal vacuum is detected, a clot detection alarm is issued to notify you and the sample is not aspirated.

competitive principle
one of three test principles available on the 2010 analyzer. It is used to detect analytes of low molecular weight (e.g., FT3).

compl 
a sample status found on the STATUS screen. The sample is complete and can be removed from the sample disk. This status is not seen for calibrators.

1. 42 United States Code of Federal Regulations. Part 493.1217. Standard; Calibration and calibration verification procedures.

compl	a sample status found on the STATUS screen. The sample is complete and be removed from the sample rack on the C-Line.
consumables	items that are used during test processing and must be replaced on a regular basis by the operator (i.e., assay cups and tips, printer paper, etc.).
consumables area	consists of three assay cup trays, three tip trays, gripper, incubator, cup disposal opening, pipetting station, liquid waste container, distilled water container and solid waste tray and liner.
container	*See sample container.*
continuous access	ability of the operator to access the sample disk to load samples at any time during operation or to place racks on the A-Line at any time during operation.
control (or quality control)	a substance with known values of analytes used to verify calibration and performance of immunoassays.
control ID	the abbreviated control name found in the software (e.g., PC U1 or PC TSH)
control name	the name of a control (e.g., PreciControl Universal).
control unit	the part of hardware that consists of the touchscreen monitor, keyboard and floppy disk drive.
cup	*See assay cup.*
cup disposal opening	opening to the left of the incubator where used assay cups are disposed into the solid waste tray.
cycle	instrument time interval of 42 seconds.

D

data disk	contains files necessary for the analyzer and the software to work together. These files include: • analyzer specific adjustment files • assay reference tables • calibration data • up to 600 orders and test results.
data entry field	a field on the software screen where you can enter or edit information. This field is touch-activated.

data field	a field on the software screen that contains information only. There is no user access. This field cannot be activated.
dead volume	the amount of sample that must remain in the container to ensure proper sample aspiration.
detection unit	contains the photomultiplier tube, peltier, flow-through measuring cell, magnet drive assembly and an amplifier circuit board. The detection unit is the core of the 2010 analyzer.
deviation of duplicate measurements	one of the six calibration quality criteria. For a calibration to be successful, replicate measurements must fall within a specific duplicate limit. The remaining criteria are missing values, monotony of curve, calibration factor, minimum signal and system errors.
diluent	*See Universal diluent.*
dilution factor	a software preset dilution ratio that is used by the analyzer to automatically perform a requested dilution. Dilutions may be 1:2, 1:5, 1:10, 1:20, 1:50 and 1:100. Recommended dilution factors are found in reagent package inserts and in product informations.
disk position	a position on either the sample or reagent disk. There are up to 30 sample disk positions. There are up to 18 reagent disk positions.
dispense	delivery of a sample or reagent by the appropriate probe to an assay cup.
distilled water container	contains the distilled or deionized water supply for the analyzer. The three liter plastic bottle is located in front of the pipettors and to the right of the liquid waste container.
DNA/RNA probe	a test principle that can be used on the 2010 analyzer. The DNA/RNA probe is for the detection of DNA or RNA molecules and is currently under development.
document	the process of printing, uploading or printing AND uploading a report for a sample which in turn transfers the sample results to the RESULTS screen.
door	*See front access panel.*
download	the transfer of information (e.g., sample ID, test requests) from the host computer system to the 2010 analyzer.

E

ECL	electrochemiluminescence. The detection technology used on Elecsys immunoassay analyzers.
empty	a sample status found on the STATUS screen. An empty sample disk or rack position exists.
error handling	process during which the analyzer attempts to recover from an error condition (e.g., a tip was not picked up from a tray). If the analyzer cannot successfully recover from the error, an alarm is issued.
expected values	the values for an assay that should be recovered for a “normal” result. Also known as normal range or reference range.
extended dynamic range	the measuring range for an assay at its highest dilution.

F

filter	a means of sorting samples that you want to view, document or print. You can filter by “Samples,” “Type” or “Document” on the RESULTS screen.
first registration date	the date that the reagent pack was first successfully scanned by the bar code reader. This date is found in the assay ‘Reagent Details’ pop-up window.
flag	an identifier used to call attention to a result. A data flag could be “S” (blocked by the system), “B” (blocked by the operator) or “R” (released by the operator). Flags are seen in conjunction with data alarms.
floppy disk	(FD) a small plastic disk coated with magnetic material on which data from a computer can be stored.
floppy disk drive	holds the data disk required for operation. The drive is located behind the front access door above the solid waste tray.
front access panel (or door)	door behind which the floppy disk drive and solid waste tray reside.
functional sensitivity	concentration at which a particular level of imprecision is obtained.

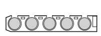
G

global action keys	keys that are found on the keyboard that remain active on all screens. These buttons include: Stat, Start, Smpl. Stop, Stop, Alarm and Doc.
gripper	a unit that moves in three directions (X, Y and Z). It is equipped with a mechanism that picks up tips or cups from the tray. The gripper picks up tips/cups and transports them to/from the incubator, aspiration station or cup disposal opening.

H

host communication	information exchange with a laboratory information system (host computer).

I

incmp	a sample status found on the STATUS screen. There was an error during processing, or the sample has a result greater than the measuring range. This status is not seen for calibrators.
incubator	an aluminum block maintained at 37 °C that accommodates 32 assay cups containing reaction mixture.
Initial BlankCell procedure	procedure performed by RD Service and utilized to maintain the sensitivity of the measuring cell and photomultiplier tube.
input buffer 	the buffer zone between the A-Line and the B-Line. It holds a maximum of five racks.
instrument alarms	displayed alarms that indicate abnormal instrument conditions (i.e., reagent disk temperature, mechanical malfunctions, etc.).
inventory control	real time monitoring of the actual amount of all consumable items on the analyzer.

L

Laboratory Information System	(LIS) external computer with appropriate software for data management (host computer)
Laboratory System Manager	(LSM) a common user interface for patient administration, sample ordering, validation and quality control in clinical chemistry and immunology.
linear bar code	a traditional 1D bar code. It has limited data capacity.
liquid level detection	(LLD) ability of the sample/reagent and sipper probes to sense liquid.
liquid waste container	contains liquid waste generated by the analyzer. The four liter plastic bottle is located in the front of the ProCell and CleanCell reagent compartments.
lot calibration	(L-Cal) a calibration performed with a fresh reagent pack that has been on the analyzer less than 24 hours. The lot calibration is valid for all other reagent packs of the same lot, provided these reagent packs were stored as specified in the package insert and not on the analyzer longer than seven days.
lower detection limit	(LDL) *See analytical sensitivity*.

M

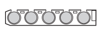
master calibration	A reference standardization curve utilizing master test kit reagents and certified reference standard material [e.g., World Health Organization (WHO) reference material] measured at Roche Diagnostics. This curve uses 10 to 12 points. The reference standard curve is the basis for the production of master calibrators.
master curve	A lot-specific master calibration curve (n=5 or 6) measured at Roche Diagnostics using lot-specific test kit reagents and master calibrators. The shape of the lot-specific master curve is characterized by a four-parameter Rodbard function. The data characterizing this curve is stored in the lot-specific reagent bar code. Lot-specific calibrator assigned values (i.e., CalSet assigned values) are read from the lot-specific master calibration curve and encoded in the CalSet calibrator bar code card.
Material Safety Data Sheets	(MSDS) documents that list components of chemical solutions and precautions for the handling and disposal of the solutions.

mean	the average value of a set of numbers, used in quality control evaluations.
measuring cell	flow-through cell where result measurement takes place. The measuring cell is part of the detection unit.
measuring range	*See reportable range.*
microparticle	paramagnetic streptavidin-coated microparticles are the solid phase used in the bound/free separation step of ECL.
microparticle mixer	paddle on the sample/reagent arm that thoroughly mixes the microparticle reagent to ensure resuspension prior to use.
minimum signal	one of the six calibration quality criteria. Each calibrator replicate value must be greater than a designated minimum signal value for a successful calibration. The remaining criteria are missing values, monotony of curve, calibration factor, deviation of duplicate measurements and system errors.
missing values	one of the six calibration quality criteria. No calibrator replicates may be missing for a successful calibration. The remaining criteria are monotony of curve, calibration factor, minimum signal, deviation of duplicate measurements and system errors.
monotony of curve	one of the six calibration quality criteria. All measured calibrator values must fall in either ascending (sandwich or bridging principle) or descending (competition principle) order for a successful calibration. The remaining criteria are missing values, calibration factor, minimum signal, deviation of duplicate measurements and system errors.

N

normal range	*See expected values.*
note	• a statement in the text called out to make the operator aware of specific information. • a result message that is displayed if a predefined result condition exist. These message are set in the software and are not user-definable (i.e, “reac.”, “n-reac.” and “border”).

O

occup	a sample status found on the STATUS screen. The sample disk position or rack position is occupied.
open request	orders for a sample that have not yet been performed.
operation	an instrument status condition that occurs when the analyzer is performing its routine operations.
operation ON/OFF switch	found on the front left of the analyzer. This switch is used to turn the analyzer ON or OFF.
operator ID	a number used to identify different operators.
order (or request)	tests selected for a specific sample or control.
output buffer 	the buffer zone between the B-Line and the C-Line. It holds a maximum of 5 racks.

P

paramagnetic	used in reference to microparticles. Microparticles themselves do not exhibit magnetic properties, but are capable of becoming magnetic when in the presence of a magnet or magnetic field.
parameters	a set of criteria used to establish how an assay is performed. All parameters are encoded on the reagent bar code label and cannot be changed by the operator.
pending requests	partial results for a sample are available; while other tests have not yet been performed or completed.
photomultiplier	a photoemissive photoelectric tube that amplifies emitted photons from the ECL reaction and converts them into an electric signal.
photon	a quantum of electromagnetic energy having both particle and wave behavior. It has no charge or mass, but possesses momentum; it carries the light emitted from the ECL reaction.
pipetting station	located to the upper left of the incubator. Cups and tips are moved by the gripper to this location for sample and reagent pipetting, sample dilution or sample pretreatment.
pop-up window	a window containing additional information that “pops up” within existing screens. It may appear as a result of touching a button on a screen.

positive displacement	water in the pipettor that is displaced by the plunger during an aspirate/dispense cycle. Is equal to the amount of sample/reagent that is aspirated/dispensed by the probe.
proc	a sample status found on the STATUS screen. The sample is in process (i.e., all assays have been pipetted), but results are not ready.
ProCell	reagent used to: • condition the electrode • transport the assay reaction mixture • wash the streptavidin-coated microparticles • generate signal.

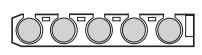
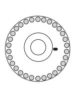
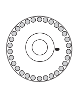
Q

QC chart	an assay/control combination. Up to 60 charts per control are stored in the QC screen.
qualitative assay	a determination of a substance without regard to quantity.
quality control	*See control.*
quantitative assay	a determination of a substance with regard to a specified number or amount.
questionable calibration	a calibration that does not successfully pass the calibration quality criteria. The curve may be manually released or rejected by the operator.

R

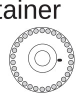
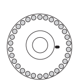
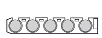
rack	a device that holds sample cups or primary sample tubes. Each rack holds a maximum of five samples. Racks are transported on the lines of the rack sampler.
rack bar code reader	auto-discriminating reader that reads both sample bar code labels and the rack ID bar code.
rack circuit breaker	located on the left side of the rack sampler. It controls power to the rack sampler unit. It should be left ON.
rack ID	the bar code on the end of the rack that identifies the rack for positive sample ID.
rack pusher arm	arms located on the A-Line, B-Line and C-Line. They push the racks along the respective line.

Glossary

rack sampler 	unit consisting of an A-Line for rack input, B-Line for transport and sampling and a C-Line for rack receipt.
reaction mixture	sample combined with reagents in the assay cup. This final mixture is aspirated into the measuring cell.
reagent cap open/close mechanism	a mechanism that automatically opens and closes the reagent caps before and after reagent pipetting. This controls reagent evaporation.
reagent disk	disk where reagent packs are located while on the analyzer. The disk contains 18 positions in total.
reagent disk cover	the cover that closes the reagent disk compartment. This cover assists in controlling the temperature of the reagent disk.
reagent disk position	one of 18 positions on the reagent disk. Its presence is monitored by a sensor.
reagent pack	reagent used on the Elecsys analyzer. It is composed of three physically connected bottles (R1, R2 and Microparticles). The components of a reagent pack cannot be interchanged with another reagent pack.
reagent pack calibration	(R-Cal) a reagent pack calibration is performed when reagent has been on board the analyzer more than 24 hours or when generated by an operator-released calibration. A reagent pack calibration is valid for one specific reagent pack only. The reagent pack calibration is compared to the most recent stored L-Cal for validation.
reagent pack number	the unique number on the reagent bottle label that identifies each reagent pack.
reagent scan	a scan of the reagent disk to read information from the 2D reagent bar code into the analyzer and update inventory.
real time	display of information on the monitor at the moment a change altering such information occurs.
regst 	a sample status found on the STATUS screen. The disk position contains a sample that was programmed or read by the bar code reader.
remov 	a sample status found on the STATUS screen. The calibrator can be removed from the sample disk. It is not for samples or controls.

renewed calibration	a calibration that is performed when the assay-specific time has expired. Refer to the *Calibrators* section of the package insert or product information for the assay specific time.
reportable range	the range of results that can be reported for the assay. It is from the lower detection limit to the maximum of the master calibration curve.
request (or order)	tests selected for a specific sample or control.
result	signal converted into concentration for the assay selected. A result is generated for each test performed.
rinse station	rinses the assay tip, mixer or probe externally with deionized water. A separate rinse station exists for the sample/reagent probe and mixer, and for the sipper probe.
Rodbard function	a calibration function used by the analyzer to convert measured signals into concentrations. It utilizes four parameters; two of which define the shape of the curve and the other two define the position of curve.
ruthenium	a rare metallic chemical element of the platinum group that is utilized in electrochemiluminescent reactions.
ruthenium complex	[Ru(byp)$_3^{2+}$] N-hydroxysuccinimide (NHS) ester. The complex is used for the development of light in ECL reactions.

S

sample container	a sample cup or primary or secondary collection tube.
sample disk 	has 30 positions for samples, calibrator and controls. Built in adapters allow intermixing of different size primary sample tubes.
sample disk position 	one of 30 available positions on the sample disk.
sample ID	the identifier for the sample. It may be up to 22 characters (alphanumeric).
sample rack 	*See rack*.
Sample/Reagent arm	(S/R arm) the horizontal moving arm that holds the sample/ reagent probe and microparticle mixer.
Sample/Reagent pipettor	(S/R pipettor) located on the back right of the analyzer. It is filled with deionized water and uses positive displacement to aspirate and dispense from the sample/reagent probe.

Glossary

Sample/Reagent probe	(S/R probe) mounted on the sample/reagent arm, it uses disposable tips to control carryover, and has liquid level and clot detection for accurate pipetting.
sample scan	a scan of the sample disk to read the information from the primary sample tubes into the analyzer to update the ORDERS screen.
sandwich principle	one of three test principles available on the 2010 analyzer. It is used to detect higher molecular weight analytes (e.g., TSH).
scan	*See bar code scan.*
screen button	a button in the software that is found on a screen (e.g., ORDERS, MAINTENANCE).
SD	standard deviation, statistic used as a measure of the dispersion or variation in a distribution, equal to the square root of the arithmetic mean of the squares of the deviations from the arithmetic mean.
select	to mark an item so that a subsequent action can be performed on that item. An item is selected by touching it on the screen.
sequence number	a number from 1 to 9999. This number is automatically assigned to each sample by the analyzer and is used to track orders.
signal	the emission of light converted into an electric signal, which is in turn converted into an analyte concentration. This value can be viewed if activated by service.
sipper arm	horizontally moving arm that holds the sipper probe.
sipper pipettor	located directly to the right of the sample/reagent pipettor. It is filled with deionized water and uses positive displacement to aspirate and dispense from the sipper probe.
sipper probe	probe that aspirates reaction mixture into the measuring cell. This probe also aspirates ProCell and CleanCell.
smpl	a sample status found on the STATUS screen. The sample currently being pipetted.
solid waste tray	metal waste container holding a liner (Clean-Liner) located behind the front access door. Used cups and tips are discarded here during operation.

S/R arm	*See Sample/Reagent arm.*
S/R pipettor	*See Sample/Reagent pipettor.*
S/R probe	*See Sample/Reagent probe.*
standard	traceable reference material solutions used to create the master calibration curve.
Stand-by	status condition that exists when the analyzer is not performing any operations.
STAT position	located at the front of the analyzer. It is an extension of the B-Line. A rack placed here is sampled after the current rack is finished.
STAT sample	(Short Turn Around Time) a sample that requires rapid turnaround. Designated by a yellow button on the STATUS screen.
status	• one of many instrument status conditions • one of eight sample statuses (i.e., empty, occup, smpl, proc, incmp, remov, compl and stop).
status line	line at the top of the touchscreen that displays the operator ID, system status (i.e., current operating conditions) and actual time. If an alarm occurs, the line changes color depending upon the severity of the alarm.
stop	a sample status found on the STATUS screen. The Stop bar code was scanned.
Stop bar code	a bar code used on the disk system to halt sample scanning.
system errors	one of the six calibration quality criteria. A hardware error occurred during a calibrator measurement. The remaining criteria are monotony of curve, calibration factor, minimum signal, missing values and deviation of duplicate measurements.

T

target range	the specified limits of a control range for an assay.
target value	the mean value of the control target range for the assay.
temperature controlled	the temperature in a compartment is held stable within a specified range. The temperature is controlled with peltier units.
test	*See assay*.
test code	the abbreviated name for a test. This code appears on the test buttons within the software.
test principle	a principle used to detect analytes on the analyzer. These include competition, sandwich, bridging and DNA/RNA probe.
test protocol	an exact sequence of test steps used to perform an assay. These test steps include pipetting sample, reagent, incubating the reaction mixture for a specified time, etc.
tip	*See assay tip.*
tip eject station	position 6 on the pipetting station. This is where the assay tips are ejected from the sample/reagent probe.
touchscreen	LCD screen located on the left side of the analyzer that displays the software. Certain actions are performed by touching buttons on the screen.
tray	a device that holds a maximum of 15 sample racks. Trays are placed on the A-Line or C-Line.
tray indication light	a light at the left side of both the A-Line and C-Line. When the light is green, you can add racks or a new tray to the A-Line, or remove a tray from the C-Line. If red, the pusher arm is about to move; do not remove a tray.
tripropylamine	(TPA) one of two electrochemically active substances used in the ECL reaction. TPA acts with the ruthenium complex to initiate the light generating cycle, which results in the emission of a photon.

U

unit of measure	assays are measured in certain concentration units. The analyzer has designated units of measure for the analytes; this information is contained in the reagent bar code.
universal diluent	reagent used to dilute samples that exceed the reportable range of the assay.
upload	the sending of information (e.g., sample ID, test results, etc.) from the analyzer to the host computer.

W

warning	a statement called out in this manual to make the operator aware of conditions that could cause damage to the analyzer or could cause personal injury.
waste	anything discarded by the analyzer. It could be liquid waste or solid waste (tips and cups).
window button	a button on the software that is found on a pop-up window (e.g. 'Reagent Details' or 'System Reset').
work list	a report generated from the ORDERS screen. It lists calibrators, controls and samples currently loaded on the sample disk, or programmed on sample racks, as well as the tests selected.

Notes